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Food related myths and use of alternative medicine in management of type 2 diabetes in northern Tanzania

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FOOD RELATED MYTHS AND USE OF ALTERNATIVE MEDICINE IN MANAGEMENT OF TYPE 2 DIABETES IN NORTHERN TANZANIA

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ABSTRACT

Type 2 diabetes is a complicated health condition with multiple causes and ways of management. It is accompanied with various myths that guide people's health seeking behavior and they may use alternative medicines and abandoning the physician medicines. This study aimed to investigate on food related myths and use of alternative medicines in management of type 2 diabetes in Northern Tanzania. A cross-sectional analytical mixed methods design was conducted. A total of 168 were interviewed and anthropometric measurements of the patients were assessed. The X-ray fluorescence (XRF) was used to determine the mineral contents of traditional medicines. Quantitative data were analyzed by Statistical Product and Services Solution (SPSS Inc.), Nutri-Survey and GenStat software. Qualitative data were analyzed thematically. Majority of the patients consumed whole fresh milk (81.4%), ground nuts (76.4%), beef (70%), beans (70%) and sunflower oil (80%). Most of them had low intake of dietary calcium (86.3%) and protein (64%). High prevalence of overweight/obese revealed among female, with primary education, aged 41-60 years, self-employed, married/cohabiting and from KCMC. Participants reported that carbohydrate rich diets cause diabetes, soaking/washing rice removes carbohydrate, traditional medicines treat diabetes, and use of both conventional and traditional medicines increase treatment efficacy. About 67.2% participants were using traditional medicines like soursop leaves, black plum barks, okra pods, moringa leaves and seeds, avocado seeds and lemongrass to manage their diabetes. These medicines contain calcium, magnesium, chromium and zinc as important minerals in diabetes management. Further study is warranted to look for other phytochemicals and their physiological effect.

DECLARATION

I, Rose Kasole do here declare to the Senate of Nelson Mandela African Institution of Science and Technology that this dissertation is my own original work and that it has neither been submitted nor being concomitantly submitted for degree award in any other institution.

Signature_____ Date 15/10/2019.

Rose Kasole

The above declaration is confirmed

Signature Martin Date 15/10/2019

Dr. Haikael D. Martin (Supervisor 1)

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Prof. Judith Kimiywe (Supervisor 2)

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CERTIFICATION

The undersigned certifies that, they have read the dissertation titled, "Food Related Myths and use of Alternative Medicines in Management of Type 2 Diabetes in Northern Tanzania" and recommend for examination in fulfilment of the requirements for the degree of Master's in Life Science of the Nelson Mandela African Institution of Science and Technology.

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DEDICATION

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LIST OF ABBREVIATIONS

ADA	American Diabetes Association
ANOVA	Analysis of Variance
BMI	Body mass index
Ca	Calcium
Cr	Chromium
ED-XRF	Energy-Dispersive X-ray fluorescence
FAICD	Fellow of the Australian Institute of Company Directors
FFQ	Food frequency questionnaire
FGD	Focus group discussion
GSF	Good Samaritan Foundation
HDL	High density lipoprotein
IDF	International Diabetes Federation
IDI	In-depth interview
Kcal	Kilocalorie
KCMC	Kilimanjaro Christian Medical Center
LDL	Low density lipoprotein
Mg	Magnesium
Mg/100g	Milligram per hundred grams
Mg/dl	Milligram per deciliter
mmHg	Millimeters of Mercury
mMol/L	Mill mole per liter
NBS	National bureau of standards
r	Correlation coefficient
RDA	Recommended dietary allowance
ROS	Reactive Oxygen Species
SD	Standard deviation
TZS	Tanzania shillings
WC	Waist circumference
WHO	World Health Organization
WHR	Waist-hip-ratio
Zn	Zinc

CHAPTER ONE

INTRODUCTION

1.1 Background information

Diabetes mellitus is a chronic health condition caused by inadequate production of insulin or inefficiency use of insulin by the body (Newman & FAICD, 2005; Jangid, Chaturvedi, & Khinchi, 2017). It is a silent killer disease because of its asymptomatic nature, and most people don't realize they are diabetic until when they develop complications. Hyperglycemia or high glucose levels in the blood is among the characteristic of diabetes (Jangid *et al.*, 2017). Chronic hyperglycemic condition poses detrimental defects in the body's organs and systems, as it causes long term damages, dysfunction and failure of organs such as blood vessels, kidneys, heart, eyes and nerves (Piero, Nzaro, & Njagi, 2015). Polyuria, polydipsia, blurred visions, impaired growth and susceptibility to infectious diseases are among the symptoms of hyperglycemia (Hassan, 2018).

There are several factors which predisposes people to diabetes, among them is obesity which is a result of high percentage of body fat in the body (IDF, 2014). This condition contribute to the rapid increase in the prevalence of diabetes worldwide (Kerner & Brückel, 2014). Prevalence of diabetes among adults aged above 18 years old is estimated to be 8.5% (422 million) globally, and 7.1% (25 million) in Africa by 2014, and 9.1% (1.7 million) in Tanzania by 2012. It is expected to increase to about 592 million globally and 41.4 million in Africa by 2035 (IDF, 2013; Mayige & Kagaruki, 2013; WHO, 2016b). About 90% of all diabetic cases worldwide are type 2 diabetes and 5-10% type 1 diabetes. Due to this exponential increase of diabetes prevalence worldwide and its life threatening effects, regarded as a public health problem.

Knowledge has a greater contribution to the development, prevention and the management of diabetes because of its impacts on changing peoples' mind-set. Proper diabetes knowledge may help to diagnose many people at the early stage of the disease before developing other complications, which may worsen the condition and complicate the management. Variation in clinical presentation and progression of diabetes bring about personalized management which depends on the type and how critical the condition is (ADA, 2018). Insulin therapy, dietary therapy and life style changes, weight reduction and treatment of hyperglycemia are among the important therapies for diabetes management, because of their insulin resistance

adjustment action (ADA, 2018). Moreover, adoption to healthful lifestyle such as dietary changes and food habits and meal patterns changes, and being physically active are important tool in diabetes management (Yannakoulia, 2006).

It is estimated that 80% of people in Africa are not yet diagnosed with diabetes, due to asymptomatic or having mild symptoms which may be ignored or attributed to certain myths (Gelaw, Abdela, Tegegne, Defersha, & Muluneh, 2014; Jangid *et al*., 2017). Myths are cultural perspectives of peoples towards health seeking, where many of them believes in spirituality and alternative treatments rather than seeking medical advice (Rai & Kishore, 2009). This could be attributed to the little knowledge and awareness they have on the proper management of the disease, which lead them into looking for alternatives such as use of traditional treatments and the likes.

Ekor (2014) and Valdez-Solana *et al.* (2015) reported that, about 80% of people worldwide depend on traditional medicines as the primary remedy for various diseases. Plants based traditional medicines are the mostly used for several decades worldwide in the management of different health complications. These traditional medicines play an important role in primary health care in many developing countries. Tanzania is among countries whose population depend on traditional remedies for primary health care because of norms and beliefs on health seeking behaviors (Nguma, 2010). This health seeking knowledge passes from one generation to another generation through stories and narrations and difficult to break the chain (Rehman, Mirza, Jehan, & Pasha, 2013). Along that, there are various plant based traditional medicines used to manage several ailments including diabetes (Lunyera *et al*., 2016). Most of those medicines are common foods, including vegetables, fruits, seeds and spices, and herbs. It has been documented that, foods provide health benefits beyond their nutritive values, because they can help to prevent and cure various diseases (Liu, 2003; Rahmatullah *et al*., 2009). Presence of various secondary metabolites, phytochemicals and elemental composition may potentiate them to be a medicinal source for diabetes management.

1.2 Problem statement and justification

Prevalence of diabetes in Tanzania is increasing at an alarming rate from 3.4% in 2000 to 9.1% in 2012 (Aspray *et al.*, 2000; Mayige & Kagaruki, 2013). The prevalence of diabetes in Kilimanjaro and Arusha were 5.7% and 16.2% respectively (Masaki, Ngoye, Petrucka, & Buza, 2015; Stanifer *et al.*, 2016). It has been reported that, 77.1% of diabetic patients in Northern Tanzania use traditional medicines as diabetes remedy, of these, 40.3% use traditional medicines only, and 37.6% use both traditional and conventional medicines (Lunyera *et al*., 2016).

Unpublished conference report presented by Maregesi in 2016 indicated that, there are various traditional medicines used by diabetic patients in management of diabetes in Northern Tanzania, and not all of them have been documented. Moreover, the documented medicines such as *Aloe vera*, *Artemisia afra* (African wormwood), *Cajanus cajan* (Pigeon pea), *Clausena anisata* (Horsewood), *Cymbopogon citratus* (lemon grass), *Hagenia asyssinica* (African redwood), *Moringa oleifera* (Moringa), *Persea american* (Avocado) and *Syzygium cumini* (java plum tree) (Lunyera *et al*., 2016; Mwanri, Lyari, & Msollo, 2018) have not explained exhaustively their bioactive compounds present which play the key role as blood glucose regulators. Also, it is not yet clear how different traditional medicines are used for disease management (Bogle & Mendes, 2015).

It has been reported that patients rely on the use of traditional medicines that leads to little or no compliance with physician prescribed dosage or medicine (Gelaw *et al*., 2014). Misconception and myths, lack of right information and high medical costs in managing the disease, may be attributed to patients resorting to use various traditional medicines, regardless of the missed information, which in turn may contribute to associated complications. Due to that the present study aimed to investigate on food related myths and the use of alternative medicine in management of diabetes in Kilimanjaro and Arusha region.

1.3 Study objectives

1.3.1 General objective

The main objective of this study was to investigate the existing food related myths and the use of alternative medicines in management of diabetes among patients attending a diabetic clinic at Mount Meru and Kilimanjaro Christian Medical Center (KCMC) hospitals in Northern Tanzania.

1.3.2 Specific objectives

Specifically the study addressed the following objectives:

(i) To assess dietary practices and nutritional status of the type 2 diabetic patients attending a clinic at the Mount Meru and the Kilimanjaro Christian Medical Center (KCMC) hospitals.

(ii) To explore myths, perceptions and practices of the used foods and/or traditional medicines in management of type 2 diabetes.

(iii) To determine the mineral content (Ca, Mg, Cr and Zn) of the common foods and/or traditional medicines used by type 2 diabetic patients in management of diabetes.

1.4 Research questions

The study answered the following questions to address the objectives:

(i) What are dietary practices and nutritional status of type 2 diabetic patients attending a diabetic clinic at Mount Meru and KCMC hospitals?

(ii) What are the myths, perceptions and practices of type 2 diabetic patients on the use of foods and/or traditional medicines?

(iii) Do the traditional medicines contain any of the selected minerals shown to have an impact on the regulation of blood glucose?

1.5 Significance of the study

The study ascertained the existing food related myths and the used traditional medicines, and established selected mineral contents (calcium, magnesium, chromium and zinc) of the selected foods and/or traditional medicines (moringa seeds and leaves, okra pods, lemongrass, black plum barks, soursop leaves and avocado seeds) used in management of type 2 diabetes. This study may help patients to make better choice of food and/or traditional medicines to use based on the mineral richness. Also, the study documented on the nutritional status and dietary practices of the type 2 diabetic patients, which may help health care providers to take action on educating their clients on the importance of weight management and healthy eating in order for them stay healthy.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

Mabaso and Oduntan (2016) explained that, diabetes mellitus is a disorder due to the abnormalities that occur in metabolism of glucose, in relation to unhealthy eating, obesity, cultural changes and inactive lifestyles which lead to lack or reduction of insulin efficiency. It is associated with several disorders like impaired vision, sexual dysfunction, and hypertension among others including increased healthcare costs and premature death or mortality (ADA, 2012). Overweight and obesity are the significant risk factors for type 2 diabetes development along with unhealthy eating, physical inactivity, smoking which poses defaults in the insulin secretory system due to the inflammation and metabolic stress (IDF, 2014; ADA, 2018). Dietary therapy, lifestyle modification and insulin therapy along with weight reduction are the most reliable options for diabetes management (Inzucchi *et al.*, 2012; WHO, 2016a).

2.2 Dietary practices and implications on health and nutritional status

Health and nutritional status of an individual or a group of people may be influenced by dietary practices which may contribute to the emerging chronic health disorders including diabetes. Change in cultural groups due to population growth, socioeconomic status, religious and cultural beliefs influences food preferences and eating habits diverse (Kulkarni, 2004; Ogbera & Ekpebegh, 2014). The increased prevalence of diabetes in various populations associated with the changes in lifestyle, dietary habits, intake of low fiber diets and dietary fatty acid (Kastorini & Panagiotakos, 2009). Consumption of highly processed grains, especially white maize flour (sembe) and white rice contribute to a burden of diet related chronic diseases, including diabetes because of high glycemic index (Barclay *et al.*, 2008; Muhihi *et al.*, 2012).

Healthful diet; dietary habits and meal patterns changes with regards to food selection, meal planning, food preparation, and portion control are basic tools for the prevention and management of diabetes (Franz *et al.*, 2002; Yannakoulia, 2006). A diet enriched with adequate amount of carbohydrates, proteins, vitamins, minerals and soluble fibers helps in proper management of diabetes (Marlett, McBurney, & Slavin, 2002). Therefore, diversification of foods in a meal may play a key role in attaining good glycemic control in

diabetes mellitus as it targets to improve the overall health by achieving and maintaining optimal nutritional status so as to prevent the acute and long term complications of diabetes.

2.3 Influence of anthropometric measurements in diabetes management

Anthropometric measurements are among the screening tools for type 2 diabetes, along with other risk factors such as age, physical inactivity, family history, dietary habit among others. Dietary diversity and pattern, and nutrient intake contribute to the body mass changes which lead to an increased prevalence of obesity (Vorster, Kruger, & Margetts, 2011). Obesity and abnormal distribution of body fat in the abdominal region of non-obese individual are the major risk factors for the development of type 2 diabetes, since these impact insulin action and lead to insulin resistance (Ebbeling, Pawlak, & Ludwig, 2002; Kerner & Brückel, 2014).

Anthropometric measurements involving body mass index, waist circumference and waist-hip-ratio (WHR) have been used as indicators to whether a person is normal, overweight or obese based on the WHO categories of measurements. The World Health Organization (WHO) classified overweight as BMI > 25 kg/m^2, obesity as BMI> 30 kg/m^2; and central adiposity as waist circumference (WC) > 94 cm for men and > 80 cm for women, and waist-hip-ratio (WHR) of ≥ 0.90 in men and ≥0. 85 in women. Furthermore; WC of 80-87.9 cm and ≥88 cm in women, and WC of 94-101.9 cm and ≥102 cm in men regarded as overweight and obese respectively. Waist hip ratio (WHR) of 0.80-0.84 and ≥ 0.85 in women, and 0.9-0.99 and ≥ 1.0 were classified as overweight and obese respectively (Dalton *et al.,* 2003; WHO, 2011). Waist circumference is regarded as a direct measure of the body composition compared to BMI, due to the link between abdominal obesity and the metabolic abnormality (Hsu, Araneta, Kanaya, Chiang, & Jujimoto, 2015; ADA, 2018). Weight reduction impacts management of type 2 diabetes, however to return normal is seldom (ADA, 2018). Therefore, weight and body fat distribution may help to alleviate the diabetes condition and the associated complications.

2.4 Food related myths and management of type 2 diabetes

Myths are cultural beliefs or traditions shared by a group of people to justify their social behavior, with strong influence in people's way of living including treatment seeking during sickness (Rehman *et al.,* 2013). Food myths are beliefs or traditions towards a certain food that symbolizes a certain society and explains their interactions with certain foods. There are various beliefs across cultures, including the use of avocado leaves, guava leaves and

eucalyptus in blood cleansing, appetite boosting and a reduction in blood sugar level (Atwine, Hultsjo, Albin, & Hjelm, 2015). Additionally, some people believe that diabetes mellitus caused by intake of carbohydrate rich foods and simple sugar, but literature explains that carbohydrates being a risk factor for diabetes, depends on the form and the content of the food consumed (Ogbera & Ekpebegh, 2014; Rahati, Shahraki, Arjomand, & Shahraki, 2014). It is accounted that about 80% of Africans are not diagnosed due to the association of the disease with myths or they ignore the symptoms (Oputa & Chinenye, 2012; Gelaw *et al.*, 2014). Lack of awareness among people with diabetes predisposes them to the burden of chronic complication and significant increase of morbidity and mortality in sub-Saharan Africa in the future (Mbanya, Motala, Sobngwi, Assah, & Enoru, 2010). Therefore, awareness creation and proper diabetes management education may eliminate risky and wrong myths existing in the society.

2.5 Diabetes diagnosis and nutritional management

Assigning the type of diabetes to an individual often depends on the circumstances present at the time of diagnosis; however, difficulties may occur in diagnosing an individual, because true diagnosis can be noticeable over time. This is because symptoms of the disease may occur interchangeably. Prior type 1 diabetes is known to occur in childhood and patients depend on insulin therapy for their survival, but nowadays even young adults suffer from this health condition. Type 2 diabetes occurs during adulthood and patients do not depend on insulin therapy, although at some point they may require insulin to manage their condition. Recent information shows that children are also presented with this condition (ADA, 2014, 2018).

Malnutrition has strong influence on the development of chronic diseases, including diabetes due to micronutrient deficiencies and over-intake of certain nutrients such as fats and carbohydrates in the form of simple sugar (WHO, 2003a). World Health Organization recommends that diabetic patient has to consume 45% carbohydrate, 10-20% protein, 35% fats of total energy, <200 mg/day of cholesterol and 50 g/day of dietary fibers (WHO, 2006). Proper dietary intake in line with WHO recommendations can reduce the incidence of short and long term complications that are detrimental to the lifespan of diabetic patients (McCorquodale, 2013; Sudhira, 2014).

Furthermore, the diagnosis of diabetes should be done when a person has fasting plasma glucose of ≥ 7.0 mMol/L and the 2-hours post-glucose in the 75 g OGTT is > 11.0 mMol/L, a

random plasma glucose of ≥200 mg/dl (≥11.1 mMol/L) and incidence of high blood glucose in urine (WHO, 1999b). Below these cut off points a person is regarded as pre- diabetic or non-diabetic depending on the blood glucose level once have.

2.6 Perceptions and practices on conventional medicine and traditional medicine believed to lower blood glucose levels

Conventional and traditional medicines perceptions and practices in management of diabetes may influence the performance on monitoring blood glucose levels among diabetic patients. Reports indicate that 77.1% of diabetic patients in Northern Tanzania use traditional medicines, of these 40.3% use traditional medicines only and 37.6% use both traditional and conventional medicines. Accessibility, effectiveness, lower costs, cultural and religious beliefs, and safeness are reasons for traditional medicine demand (Calixto, 2000; Lunyera *et al*., 2016). However, failing to adhere with the physicians prescribe dosage or medicine by relying on traditional medicines may predispose diabetic patients into worse condition (Gelaw *et al*., 2014).

2.7 Mineral composition of traditional medicines used in the management of diabetes

Apart from offering nutritive components, plants also have chemical compounds which provide medicinal benefits to humans. Various studies have documented that foods provide health benefits beyond their nutritive values, as they can help to prevent and cure various diseases (Liu, 2003; Rahmatullah *et al*., 2009). Plants have been used for a number of years in various countries worldwide as a primary remedy on health care grounds. It has been reported by the World Health Organization (WHO) that about 80% of people rely on traditional remedies as primary health care (Ekor, 2014; Valdez-Solana *et al*., 2015). Presence of various secondary metabolites, phytochemicals and elemental composition potentiates these plants to be a medicinal source for primary health care. Due to their influence on cellular activities such as antioxidants, anti-inflammations and protective agents against metabolic disorders, including diabetes (Nile & Park, 2014; Oh & Jun, 2014). Additionally, these compounds help to overcome the inefficiency of the human endogenous defense system influenced by pollutions, smoking, radiations, foods, aging, obesity and inflammations (Bouayed & Bohn, 2010; Sen & Chakraborty, 2011).

Chromium, magnesium, calcium and zinc are among the beneficial minerals with a positive effect in diabetes management by improving insulin production or sensitivity and glucose

metabolism (Kibiti & Afolayan, 2015). Calcium enhances insulin secretion and sensitivity, and improves glucose uptake by increasing the affinity of insulin receptors (Alvarez & Ashraf, 2010; Valdez-Solana *et al.*, 2015). Chromium increases sensitivity of the insulin and improves fasting and glucose tolerance among glucose intolerance individuals (Cefalu & Hu, 2004; Hajra *et al.*, 2016). Magnesium has an influence on glucose metabolism, insulin performance, and insulin receptor activity (Gröber, Schmidt, & Kisters, 2015). Nevertheless, zinc is involved in insulin synthesis, storage and secretion, and improves insulin sensitivity and glucose utilization (Capdor, Foster, Petocz, & Samman, 2013). Due to the presence of these nutritive compounds and their medicinal effects on human beings has potentiated most of the plants for primary health care worldwide.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study approach

This study used quantitative and qualitative approaches (mixed method) to collect the relevant information. The use of both of these approaches aimed to complement the findings of each other, and extended the room for triangulation of both instruments for data collection. Johnson and Christensen (2008) comment that use of two approaches is superior to the use of single approach. Quantitative approach was conducted among type 2 diabetic outpatients to gather information related to myths, perceptions and practices on the used foods and/or traditional medicines in management of diabetes, along with demographic information, anthropometric characteristics, dietary practices, blood glucose levels and blood pressure. The collected quantitative data aimed to provide further information to complement the qualitative data. The researcher used a qualitative approach to collect in-depth information through focus group discussion (FGD) with type 2 diabetic patients, and in-depth interview among traditional medicines vendors/local herbalists. The foods and/or traditional medicines which were found to be used by many patients were subjected to nutrient analysis, especially minerals having an association to blood glucose regulation by improving insulin performance or glucose metabolism.

3.2 Study design

The study employed cross-sectional analytical mixed method approach under embedded design, where findings from quantitative and qualitative approaches supported and supplemented each other on the study. Qualitative data used to obtain in- depth information about the problem which further supported with quantitative data (Creswell, 2012).

3.3 Study site

The study was conducted in Arusha and Kilimanjaro region, involving Mount Meru and Kilimanjaro Christian Medical Centre (KCMC) hospitals respectively (Fig. 1). These are health facilities which provide specialized diabetes care in Kilimanjaro and Arusha region. Kilimanjaro region has 1 640 087 people and Arusha 1 694 310 people (NBS, 2012). Kilimanjaro Christian Medical Center (KCMC) is a zone hospital located on the slopes of Mount Kilimanjaro and established by the Good Samaritan Foundation (GSF) since 1971 to serve people in the Northern Tanzania. Mount Meru is a regional referral hospital located in

the foothills of Mount Meru and established in 1926 and owned by the Tanzania government to serve Arusha region's population.

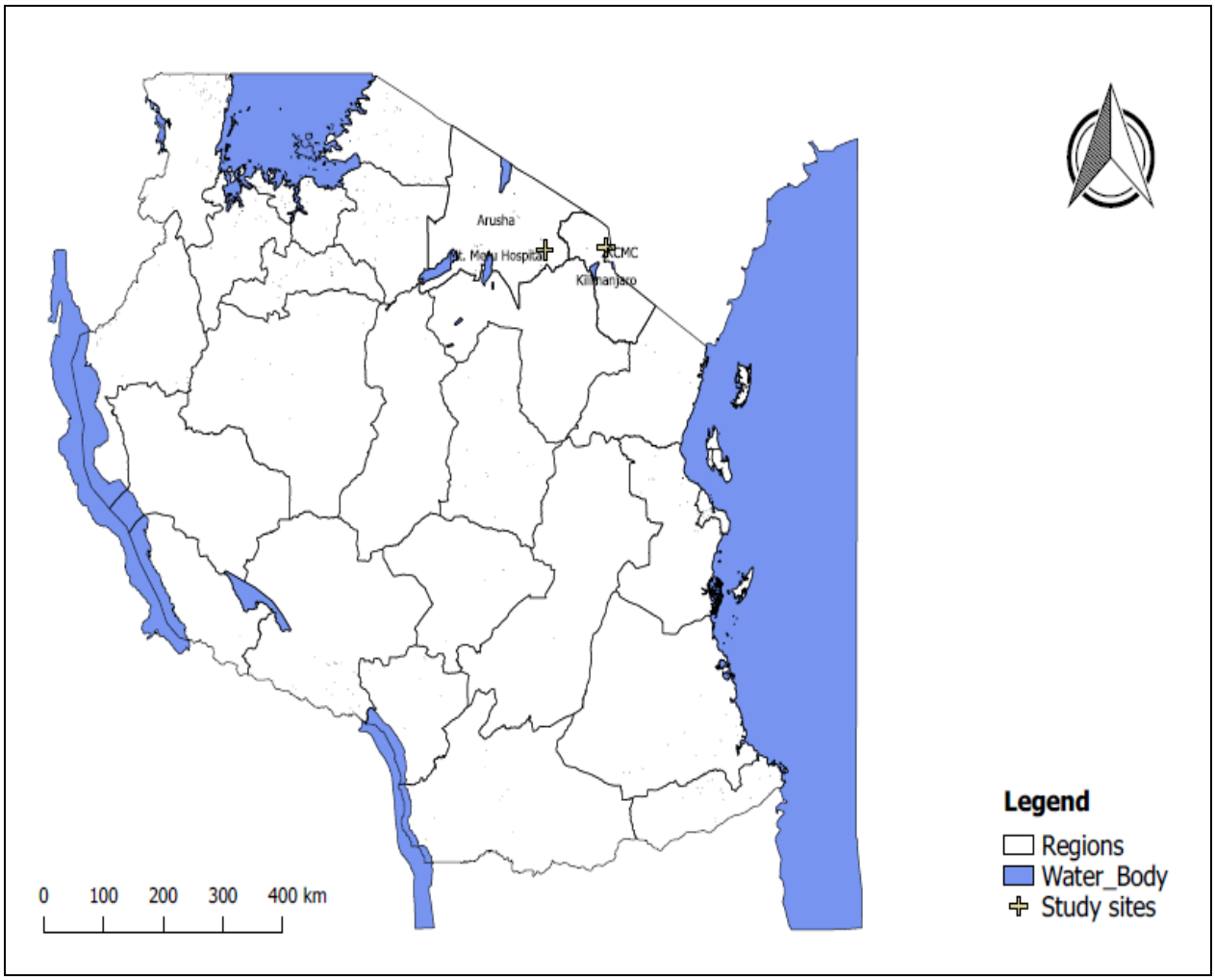

Figure 1: A map showing the location of the study sites in Arusha and Kilimanjaro Regions

3.4 Study population

The study participants were type 2 diabetic outpatients who attended clinic at Mount Meru and KCMC hospitals and local herbalists. Pregnant women were excluded from the study because they might have gestational diabetes and not necessary type 2 diabetes. Also, type 1 diabetic patients and those with complications like amputation and retinopathy were not included because these may hinder their mobility and influence their nutritional status.

3.5 Sampling techniques and sample size determination

3.5.1 Sampling techniques

Being a mixed method study, purposive and stratified random sampling techniques considering their benefit over other procedures were employed. Purposive sampling was used to select hospitals, patients and local herbalists based on Teddlie and Yu (2007) protocol . The patients were stratified according to their sex, two strata of 10 patients each were formed, in which FGDs participants were drawn. Questionnaire participants were randomly selected by counting numbers and all even number counts were included in the interview. Snowball sampling was used to recruit herbalists who participated in in-depth interview (IDI).

3.5.2 Determination of sample size

There were 4 FGDs with 5 participants in each. One FGD for males and one FGD for females were conducted at each hospital. Four potential IDI participants were picked from each region (Kilimanjaro and Arusha) at their working place/shops for interview. The sample of the questionnaire participants was obtained by using a formula adapted from Gelaw *et al*., (2014) with the following parameters: 9.1% prevalence of diabetes (P) in Tanzania, 5% margin of error (E), and a standard normal deviation (Z) of 1.96, and a contingency of 10%.

Formula; $N = Z^2 \frac{P(1-P)}{E^2}$ + 10% contingency

N= ($1.96^2 \frac{0.091(1-0.091)}{0.05^2}$ =127, 10% contingency of 127 =127(10/100) =12.7

127+12.7=139.7≈140

Table 1: Distribution of the sample size per region

Region	Questionnaire	FGD	IDI	Total
Kilimanjaro	78 (Table 2)	10	4	92
Arusha	62 (Table 2)	10	4	76
Total sample	**140**	**20**	**8**	**168**

3.6 Methods of data collection

3.6.1 Questionnaire and interview

Data collection was conducted from March to June, 2018 among patients attending diabetic clinic at Mount Meru and KCMC hospitals and local herbalist found at their working places. The open-and closed ended questionnaire was used to interview the patients who attended the clinic at the selected hospitals. This questionnaire was aimed to collect quantitative data related to the patients' perspectives towards food related myths and the used traditional medicines in management of diabetes, frequency of use, reasons of use, state of the medicines used, the source and diabetes associated complications managed by the listed traditional medicines. Data related to socio-demographic information, anthropometric measurement, dietary practices, and blood glucose and blood pressure among type 2 diabetic outpatients attended at selected hospitals were collected in the same way. The questionnaire was constructed in English language, translated into Swahili language and pre-tested on 8 diabetic patients from KCMC prior to data collection activity. Amendment of the questionnaire was done depending on the responses obtained to suit the theme of the study. The final version of the questionnaire was administered to the type 2 diabetic adults aged above 20 years old attending diabetic clinics at Mount Meru and KCMC hospitals under the guidance of the researcher and a trained research assistant.

Also, checklist questions were prepared and used to gather qualitative information related to patients' and local herbalists' perspectives towards the used foods and/or traditional medicines in management of diabetes. The interview was conducted through FGD with type 2 diabetic patients attending the diabetes clinic at Mount Meru and KCMC hospitals. Also, in-depth interview was conducted among 8 traditional medicine vendors/local herbalists to capture their general knowledge of diabetes, perceptions and practices towards foods and/or traditional medicines used in management of diabetes. The FGDs were held in each selected hospital at a space provided by nurse's in-charge and IDIs were done in the participants' work place and lasted one and half hours. Open-ended and probing questions were used for discussion and interviews. The questions were initially written in English and then translated to Swahili language. All responses were audio-recorded and included note-taking by a research assistant, transcribed and translated by the researcher, these were then reviewed and moderated under the guidance of qualitative data analyst expert to ensure accuracy.

3.6.2 Food frequency questionnaire and 24 hours dietary recall

The modified descriptive qualitative food frequency questionnaire (FFQ) and 24 hours dietary recall methods were used to assess patients' dietary patterns. The food frequency questionnaire (FFQ) was prepared to suit the context of the research and the foods available in the participant's locality. The FFQ had nine food groups; cereals, roots/ tubers and plantains, legumes, nuts, vegetables, fruits, drinks, meat and eggs, and milk and was administered to the participants by the researcher and research assistant. Each participant was asked to state the type of foods and the frequency of intake of each food per day, week, and month, rarely and not eaten (Appendix 1).

Furthermore, 24 hours dietary recall was used to assess the participant's number of meals, place meal was taken, foods eaten, method of preparation, ingredients added in the food and the portion size of food eaten. The data were recorded in the printed paper and patients were asked to recall all foods and drinks taken over the last 24 hours in chronological order. Common household utensils such as plates, spoons, cups, bowls and glasses of varying sizes were used to estimate the portion size and the weight of the food eaten. Size variations of the utensils allow patients to select the best size that reflects the portion size eaten. Each patient managed to recall the portion size of the food they ate, which then was converted into weight equivalents based on the pre-weighed food or drinks contained in the selected utensils. Digital kitchen weighing scale and measuring cylinder were used to weigh the food and drinks respectively contained in the utensils administered to the patients. Daily dietary nutrients intake was calculated by using Nutri-survey Software version 2007 (Erhardt, 2014), and Tanzania Food Composition Table version 2008 (Lukmanji *et al*., 2008), for the food which were not present in the Nutri-survey software (Appendix 1).

3.6.3 Anthropometric measurements

Digital scale (Electronic personal scale, model: Secca 874 U) used to measure patients' weight, wooden stadiometer with a sliding head bar measured the heights of patients, Anthro-tape used to measure waist circumference and hip circumference in accordance to the standards of anthropometric techniques. Body mass index (BMI) was obtained as a ratio of weight in kilogram to the height in meter squared (kg/m^2), and the waist hip ratio (WHR) as a ratio of waist circumference in centimeter to the hip circumference in centimeter as per WHO protocols (WHO, 2011). All the measurements were taken at nearer zero, waist circumference was taken at the midpoint of the last rib and top of the iliac crest, hip

circumference was done at the widest portion of the buttocks. Waist and hip circumference were taken while the tape snagged around the body, not too tight, and the subject was standing with arms aside, feet close together, evenly distributed weight across the feet and relaxed. Each measurement was repeated twice and the average determined to minimize error.

3.6.4 Blood glucose and blood pressure test

Secondary data of fasting blood glucose level and blood pressure were collected from the patients 'cards. Patients with fasting blood glucose level of < 7.0 mmol/L were considered to have normal blood glucose level and those with greater than that were considered to have high blood glucose level (WHO, 1999b). Patients with blood pressure of ≤139/≤89 mm/Hg and ≥140/ ≥90 mm/Hg were considered to be normotensive and hypertensive respectively (WHO, 2005).

3.7 Laboratory analysis

3.7.1 Sample collection and preparation for analysis

The patients and herbalists identified moringa seeds and leaves, okra pods, soursop leaves, lemongrass, local variety avocado seeds and black plum barks as the most common traditional medicines used in management of diabetes. A sample of each plant was collected randomly. Moringa seeds, young leaves of moringa and soursop, black plum barks, lemongrass and young green okra pods were picked from diabetic patients' farms and a local variety of avocado was bought from the market, taken off the fresh and the outer layer have the seed (Appendix 3). The collected samples were transported to NM-AIST laboratory in a cool box, washed in distilled water to remove dust and oven dried at 70 °C for 48 hours. The dried samples were ground into a fine powder by using an electrical grounder. The powdered samples were analysed at Tanzania Atomic Energy laboratory for mineral determination by using X-ray Fluorescence Machine. Each sample was sieved by using a 150 μm sieve to obtain a very fine powder. Four grams of each powdered sample and the standard was mixed with 0.9 g of a binder (Cereox, Bedburg-Hau, Germany) and homogenized by using a homogenizing machine (FRITSCH, Idar-Oberstein, Germany) at 180 rpm for 10 minutes.

Each homogenized sample was pressed in a Retsch hydraulic press at 12.5 t for 1 minute to form the pellets/tablets. Quantification of the elements and sensitivity calibration of each analyzed element (calcium (Ca), chromium (Cr), magnesium (mg) and zinc (Zn)) was based

on Trace element in spinach standard and standard reference material 1573a of tomato leaves obtained from National Institute of Standards and Technology (NIST), US Department of Commerce. The procedure was based on the XRF-SPECTRO XEPOS protocol adapted from (Jasper, Yakubu, & Baganjiya, 2017; Guevara *et al*., 2018).

3.7.2 EDXRF samples analysis

Energy-Dispersive X-ray fluorescence (ED-XRF) SPECTRO XEPOS, Bremen-Germany) was used to determine the mineral contents of the traditional medicine samples. This is a non-destructive method with high resolution elemental data, limited time for sample preparation, and low production of hazardous wastes, portability and capability of analyzing elements from sodium to uranium to capture interested elements.

The SPECTRO XEPOS contain 12-sample auto-sampler; gas supply bottle Helium for improvement of sensitivity and Pd-target end window tube for light elements at a maximum power of 50 W and voltage of 50 kV. Optimization of the excitation radiation for different elements was done by Varian VF-50J-Pd industry x-ray tube with 0.003 Beryllium window, Anode and copper body with Palladium target angle of 90^0 from central ray. The equipment runs under TurboQuant (TQ) -9232 method that includes data acquisition, spectrum analysis and interpretation and quantitative analysis facilities. Each sample and standard pellet was irradiated for 20 minutes at fixed tube conditions. Presence of minerals was verified by the established spectrum peaks (Appendix 2). Triplicate analysis of each sample and working standard was done, and the analyzed data reported as mg/kg, which was then converted into mg/100 g.

3.8 Data analysis procedure

The data were subjected to editing, coding, classification and tabulation for the purpose of summarizing and ensuring its accuracy and arranged into homogeneous groups. This was done based on the objectives of the study. In this study data analysis applied both quantitative and qualitative approaches.

3.8.1 Qualitative data analysis

Qualitative data were analyzed according to Miles and Huberman (1994) who focused on three stages of data analysis. The first stage was data reduction, which started at very initial research phase. At this stage some aspects of data were highlighted, other minimized and

others discarded. Second stage was data display, where data were organized and compressed. The last stage was conclusion drawing and verification; this involved deciding what the data mean-what their implications are for the research questions.

3.8.2 Quantitative data analysis

The Statistical Product and Service Solutions (SPSS Inc.) version 20 was used to process the collected data. First, data were coded and were entered into SPSS software and subjected to descriptive analysis. Descriptive analysis was used to summarize the information related to the frequencies and the percentage of data distribution. Nutri-survey software version 2007 and Tanzania Food Composition Table version 2008 were used to calculate dietary nutrient intake of the patients, which then were handled in the excel sheet and transferred into the SPSS sheet for further analysis. The mean age, nutrient intake, anthropometric indices; height, weight, hip circumference, body mass index (BMI), waist circumference (WC), waist-hip-ratio (WHR) and dietary intake were calculated by using one sampled t-test and independent sample t-test so as to make comparisons. The associations among variables such as socio-demographic characteristics, dietary patterns and nutrient intake, anthropometric characteristics, treatment choice and blood glucose levels were made by Pearson chi-square (χ^2) at $p<0.05$ and correlation analysis at $p<0.05$. The Mg, Ca, Cr and Zn composition from the selected traditional medicines were analyzed by using GenStart 15.1 for PC/Windows, VSN International Limited and the data were analyzed using one-way analysis of variance (ANOVA). The mineral content of each sample was separated by the Duncan's multiple range tests and expressed as means, with statistical significance when $P < 0.001$.

3.9 Ethical consideration

Ethical clearance was sought from the National Institute for Medical Research (NIMR) with certificate No. NIMR/HQ/R.8a/Vol. IX/2718 (Appendix 4). Permission to conduct the study at the selected hospitals was obtained from the respective authorities. Participants were well informed about the study and requested for their informed written consent to participate in the study (Appendix 5). The purpose and objectives of the study were clearly explained to the participant. There were no known risks involved; interviews were conducted in a conducive environment. Participants were assured that participation is voluntary and they could withdraw from the study at any time.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

4.1.1 Socio-demographic characteristics of the study participants

Table 2 presents the socio-demographic characteristics of the 140 participants who responded to questionnaire, with the mean age of 56.69±12.811 years. Of these participants, 50.7% were aged between 41-60 years, 66.4% were females, 55.7% were from KCMC, 63.6% had a primary level of education, 48.6% were self- employed, 27.1% had monthly income of <250 000 TZS and 64.2% had diabetes for more than five years (Table 2).

Table 2: Socio-demographic characteristics of the study respondents (N=140)

Characteristics	n	%	Mean age
Gender			
Male	47	33.6	
Female	93	66.4	
Age (years)			56.69±12.811
21-40	14	10.0	
41-60	71	50.7	
>60	55	39.3	
Clinic center			
KCMC	78	55.7	
Mount Meru	62	44.3	
Marital status			
Never married	10	7.1	
Married or cohabiting	102	72.9	
Separated or divorced	6	4.3	
Widowed	22	15.7	
Level of education			
Never went to school	5	3.6	
Primary school	89	63.6	
Secondary school	23	16.4	
College/ university	23	16.4	
Employment status			
Formal employment	24	17.1	
Self-employed	68	48.6	
Retired officer	19	13.6	
Unemployed	29	20.7	
Monthly average income in TZS			
<250 000	38	27.1	
250 000-450 000	28	20.0	
500 000-1 000 000	22	15.7	
Have no income source	21	15.0	
Refused to disclose	31	22.1	
Duration of the disease			
<1 Year	7	13.2	
1-5 years	12	22.6	
>5 years	34	64.2	

Note *n*: Frequency, TZS: Tanzanian Shillings and SD: standard deviation

4.1.2 Nutritional status of diabetic patients in Kilimanjaro and Arusha

Table 3 presents the mean anthropometric measurements: height, weight, hip circumference, BMI, WC and WHR of the diabetes patients**.** Males were taller than females, while females had large weight and hip circumference compared to males. Also, females had mean values of BMI, WC and WHR above the WHO cutoff point which indicates that, they are overweight/ obese, while males found to be normal based on BMI and WC, but overweight based on the WHR.

Table 3: Mean anthropometric measurements: height, weight, hip circumference, BMI, WC and WHR of the diabetes patients (N=140)

Characteristics	Mean ±SD		
	Total	M	F
Height	161.37 ± 7.56	166.42 ± 6.33	158.82 ± 6.84
Weight	69.74 ± 15.25	65.88 ± 12.32	71.69 ± 6.84
Hip circumference	103.88 ± 13.12	97.10 ± 8.67	107.31 ± 13.67
BMI	26.86 ± 5.94	23.78 ± 4.04	28.42 ± 6.15
WC	91.93 ± 11.87	88.44 ± 10.08	93.69 ± 12.36
WHR	0.89 ± 0.06	0.91 ± 0.06	0.87 ± 0.06

Note SD: Standard deviation BMI: Body Mass Index in kg/m^2, WC: Waist Circumference in cm and WHR: Waist-Hip-Ratio, M: male, F: female

4.1.3 Association between socio-demographic characteristics and the patients' nutritional status (WC and WHR)

Table 4 demonstrates the association of socio-demographic characteristics on nutritional status of type 2 diabetic patients. High prevalence of overweight/central obesity was revealed among the study participants. Female were statistically significant overweight/obese than males ($p<0.05$). Patients who attend diabetic clinic at KCMC were statistically significant overweight/obese based on WC compared to the ones from the Mount Meru hospital in Arusha ($p<0.05$). Also, patients aged 41-60 years old were significantly overweight/obese based on WHR than the rest. Also, high prevalence of overweight/central obesity unveiled among patients with primary education, married/cohabiting and self-employed, though the association was not statistically significant. Generally, most of the patients were overweight/central obese.

Table 4: Association between socio-demographic characteristics and anthropometric measurements (WC and WHR)

Characteristics	Anthropometric measurements							
	WHR				WC			
	Normal	Overweight	Obese	P-Value	Normal	Overweight	Obese	P-Value
Center	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	
KCMC	16 (34.8)	17 (58.6)	45 (69.2)	0.001	11 (42.3)	24 (51.1)	43 (64.2)	0.119
Mt. Meru	30 (65.2)	12 (41.4)	20 (30.8)		15 (57.7)	23 (48.9)	24 (35.8)	
Gender								
Male	34 (73.9)	7 (24.1)	6 (9.2)	0.000	19 (73.1)	25 (53.2)	3 (4.5)	0.000
Female	12 (26.1)	22 (75.9)	59 (90.8)		7 (26.9)	22 (46.8)	64 (95.5)	
Age (years)								
21-40	8 (17.4)	1 (3.4)	5 (7.7)	0.321	7 (26.9)	1 (2.1)	6 (9.0)	0.02
41-60	22 (47.8)	15 (51.7)	34 (52.3)		11 (42.3)	25 (53.2)	35 (52.2)	
>61	16 (34.8)	13 (44.8)	26 (40.0)		8 (30.8)	21 (44.7)	26 (38.8)	
Education level								
Never went to school	4 (8.7)	0	1 (1.5)	0.201	1 (3.8)	2 (4.3)	2 (3.0)	0.129
Primary school	30 (65.2)	17 (58.6)	43 (66.2)		14 (53.8)	32 (68.1)	44 (65.7)	
Secondary school	7 (15.2)	7 (24.1)	8 (12.3)		9 (34.6)	4 (8.5)	9 (13.4)	
College/ university	5 (10.9)	5 (17.2)	13 (20.0)		2 (7.7)	9 (19.1)	12 (17.9)	
Marital status								
Never married	5 (10.9)	1 (3.4)	4 (6.2)	0.302	4 (15.4)	2 (4.3)	4 (6.0)	0.135
Married or cohabiting	37 (80.4)	19 (65.5)	46 (70.8)		20 (76.9)	38 (80.9)	44 (65.7)	
Separated or divorced	1 (2.2)	2 (6.9)	3 (4.6)		0	1 (2.1)	5 (7.5	
Widowed	3 (6.5)	7 (24.1)	12 (18.5)		2 (7.7)	6 (12.8)	14 (20.9)	
Employment status								
Formal employment	7 (15.2)	4 (13.8)	13 (20.0)	0.887	4 (15.4)	10 (21.3)	10 (14.9)	0.563
Self-employed	24 (52.2)	13 (44.8)	33 (50.8)		17 (65.4)	20 (42.6)	33 (49.3)	
Unemployed	9 (19.6)	6 (20.7)	12 (18.5)		2 (7.7)	10 (21.3)	15 (22.4)	
Retired officer	6 (13.0)	6 (20.7)	7 (10.8)		3 (11.5)	7 (14.9)	9 (13.4)	

Note n: Frequency, WC: Waist circumference, WHR: waist -hip-ratio, and chi-square tested at $p<0.05$

4.1.4 Dietary pattern of cereals, roots/tubers/cooked bananas, meat, fish, poultry and eggs

Table 5 indicates the frequency of consumption of cereals, roots/tuber/green/cooked bananas, meat, fish, poultry and eggs among study participants. The study reports, 69.3% and 65% of participants who were consuming maize and green/cooked bananas, whereas 63.8% consumed maize source foods daily and 68.2% consumed green/cooked bananas on a weekly basis as their main carbohydrate source. However, 63.6% of them were consumed unrefined cereals, especially maize food such as stiff porridge (Fig. 2). Majority consumed animal

source protein foods, especially beef, fish, milk and eggs. Seventy percent of the study participants consumed beef with consumption frequency of 1-2 times per week (81.6%), and fish was consumed by 42.1% of the overall participants while, 67.6% consumed on a daily basis. Additionally, consumption of whole fresh milk was very high (81.4%), with 92.9% consuming milk on a daily basis. About 76.4% participants were consuming eggs and most of them had consumed more than 2 eggs per meal.

Table 5: Consumption pattern of cereals, roots/tubers/cooked bananas, meat, fish, poultry and eggs by diabetic patients (N=140)

Food	Frequency of consumption						
	Total	**Daily**	**1-2 per week**	**≥3 times per week**	**1-3 times per month**	**Rarely**	**Not consumed**
Cereal based foods	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Maize	97 (69.3)	51 (63.8)	19 (76)	27 (77.1)	0	0	0
Rice	20 (14.3)	13 (16.2)	1 (4)	6 (17.1)	0	0	0
Sorghum, wheat and finger millet	23 (16.4)	16 (20)	5 (20)	2 (5.7)	0	0	0
Root, tubers and cooked bananas							
Cassava and yams	20 (14.3)	5 (12.2)	6 (17.1)	5 (11.4)	2 (18.2)	2 (22.2)	0
Sweet and round potatoes	29 (20.7)	7 (17.1)	9 (25.7)	9 (20.5)		4 (44.4)	0
Green/cooked bananas	91 (65.0)	29 (70.7)	20 (57.1)	30 (68.2)	9 (81.8)	3 (33.3)	0
Red meat							
Beef	98 (70)	9 (81.8)	40 (81.6)	29 (76.3)	9 (90)	11 (55.6)	0
Pork and goat meat	16 (11.4)	0	5 (10.2)	4 (10.5)	1 (10)	6 (33.3)	0
Offal	13 (9.3)	2 (18.2)	4 (8.2)	5 (13.2)	0	2 (11.1)	0
Do not eat meat	13 (9.3)	0	0	0	0		13 (100)
White meat							
Poultry	19 (13.6)	5 (13.5)	6 (13.6)	6 (13)	2 (15.4)	0	0
Fish	88 (62.8)	27 (73.0)	22 (50.0)	32 (69.6)	7 (53.9)	0	0
Sardines	33 (23.6)	5 (13.5)	16 (36.4)	8 (17.4)	4 (30.8)	0	0
Milk							
Cow or goat's whole fresh milk	114 (81.4)	92 (92.9)	9 (69.2)	8 (57.1)	5 (38.5)	0	0
Yoghurt or Processed milk	26 (18.6)	7 (7.1)	4 (30.8)	6 (42.9)	8 (61.5)	1 (100)	0
Eggs							
One egg	48 (34.3)	3 (23.1)	11 (33.3)	7 (70)	0	27 (52.9)	0
≥Two eggs	59 (42.1)	10 (76.9)	22 (66.7)	3 (30)	0	24 (47.1)	0
None	33 (23.6)	0	0	0	0	0	33 (100)

Note *n*: Frequency

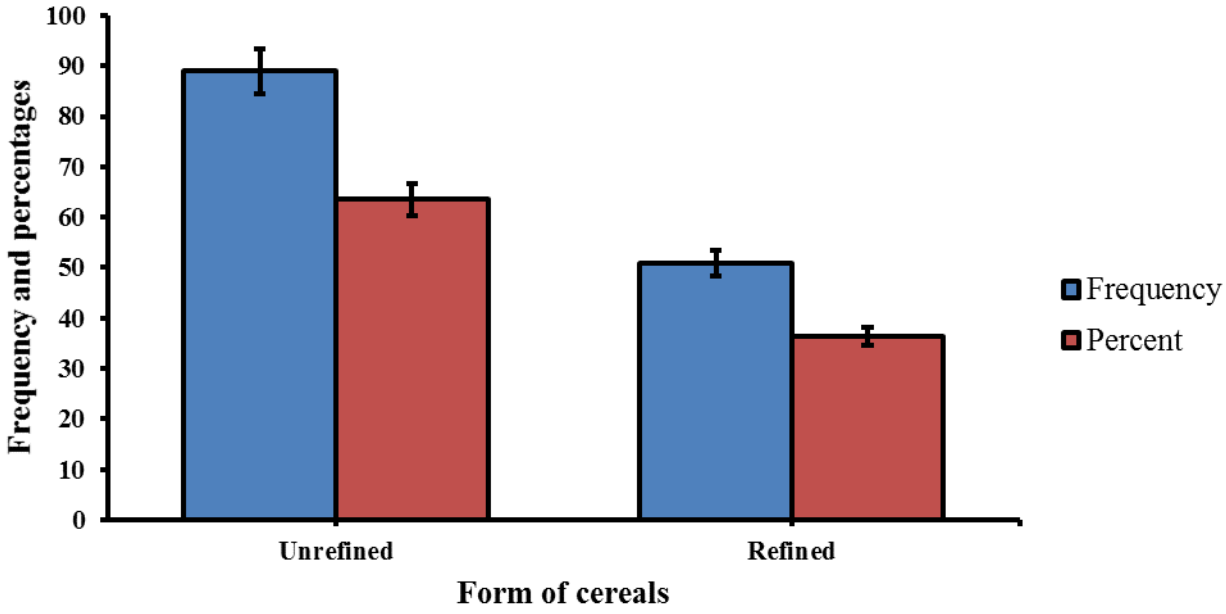

Figure 2: Form of the cereals consumed by diabetic patients

4.1.5 Dietary pattern of vegetables and fruits

Table 6 presents the frequency of consumption for various vegetables and fruits among the study participants. The most consumed leafy vegetables were amaranths (47.1%) which were consumed daily by 52.5% of participants. The non-leafy vegetables were mostly preferred; 29.3% consumed the mixture of African egg plants, eggplants and okra pods, 23.6% consumed okra alone and 71.4% consumed a mixture of onions, tomatoes, carrots, and sweet pepper in daily basis. Avocado and ripe bananas were among the preferred fruits; whereby 30.7% of the participants consume avocados only and 27.9% consume both avocados and ripe bananas on a daily basis.

Table 6: Consumption pattern of vegetables and fruits by diabetic patients (N=140)

Vegetable and fruits	Frequency of consumption				
	Total	**Daily**	**1-2 per week**	**≥3 times per week**	**Not consumed**
Leafy vegetables	n (%)	n (%)	n (%)	n (%)	n (%)
Cabbage and sweet potato leaves	27 (19.3)	14 (14.1)	6 (42.9)	7 (25.9)	0
Amaranths	66 (47.1)	52 (52.5)	3 (21.4)	11 (40.7)	0
Other vegetables such as cassava leaves, pumpkin leaves, Chinese cabbage, cowpeas leaves, nightshade leaves etc.	47 (33.6)	33 (33.3)	5 (35.7)	9 (33.3)	0
Non- leaf vegetables					
Eggplants	25 (17.9)	17 (24.6)	7 (21.9)	1 (3.6)	0
African egg plants	31 (22.1)	21 (30.4)	4 (12.5)	6 (21.4)	0
Okra	33 (23.6)	13 (18.8)	9 (28.1)	11 (39.3)	0
Mixture of Eggplants, African eggplants and Okra	41 (29.3)	18 (26.1)	12 (37.5)	10 (35.7)	0
None of them	10 (7.1)	0	0	0	10 (100)
Condiments					
Carrot and tomatoes	14 (10)	11 (9.3)	2 (18.2)	1 (9.1)	0
Onions	26 (18.6)	26 (22)	0	0	0
Mixture of tomato, onions, carrot, sweet pepper, ginger and garlic	100 (71.4)	81 (68.6)	9 (81.8)	10 (90.9)	0
Fruits					
Orange	18 (12.9)	17 (17.3)	0	1 (2.4)	0
Cucumber	11 (7.9)	4 (4.1)	0	7 (16.7)	0
Avocado and ripe bananas	82 (58.6)	60 (61.2)	0	22 (52.4)	0
Other fruits such as mangoes, watermelon, pineapple, guavas, pears	29 (20.7)	17 (17.3)	0	12 (28.6)	0

Note *n*: Frequency

4.1.6 Dietary patterns of legumes, nut seeds, alcohol, soft drinks and fats/oils

Table 7 shows the frequency of consumption of legumes, nut seeds, alcohol, soft drinks and fats/oils among the study participants. High consumption of beans and groundnuts were observed among the participants, whereby, about 70% of participants were consuming beans and most of them (72.3%) consumed one to two times per week. Groundnuts were consumed by 76.4% of the participants and 92.9% consumed daily. Only 27.9% were found to drink alcohol and 57.1% were taking carbonated drinks like coke/soda. More than 80% of the participants use sunflower oil as the main source of cooking oil and 80.7% of participants were not using sugar or sweets.

Table 7: Consumption pattern of legumes, nut seeds, alcohol, soft drinks and fats/oils by diabetic patients (N=140)

Legumes and nuts	Frequency of consumption						
	Total	**Daily**	**1-2 per week**	**≥3 times per week**	**1-3 times per month**	**Rarely**	**Not consumed**
Legumes	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Beans	97 (69.3)	30 (81.1)	34 (72.3)	26 (63.4)	4 (50)	3 (42.9)	0
Green gram	22 (15.7)	3 (8.1)	7 (14.9)	8 (19.5)	2 (25)	2 (28.6)	0
Other legumes, including coupes, green peas, chickpeas, pigeon peas, Bambara nuts and soybeans	21 (15.0)	4 (10.8)	6 (12.8)	7 (17.1)	2 (25)	2 (28.6)	0
Nuts							
Ground nuts	107 (76.4)	39 (92.9)	30 (85.7)	17 (68)	11 (68.8)	10 (71.4)	0
Other nuts such as Coconuts, cashew nuts and oyster nuts	25 (17.9)	3 (7.1)	5 (14.3)	8 (32)	5 (31.2)	4 (28.6)	0
Do not prefer any of the nuts	8 (5.7)						8 (100)
Alcohol e.g. beer							
1-2 bottles	39 (27.9)	0	9 (100)	0	10 (100)	20 (100)	
None	101 (72.1)	0	0	0			101 (100)
Carbonated drinks e.g. coke/soda							
1-2 bottles	80 (57.1)	0	17 (100)	0	29 (100)	34 (100)	60 (100)
None	60 (42.9)	0		0			
Oil/fat							
Sunflower oil	113 (80.7)	0	0	0	0	0	0
Safi, Korie and Sunora oil	19 (13.6)	0	0	0	0	0	0
Other oil/fats such as butter, lard and gold fry	8 (5.7)	0	0	0	0	0	0
Sugar or sweets intake	27 (19.3)	0	0	0	0	0	0
Yes	113 (80.7)	0	0	0	0	0	0
No							

Note *n*: Frequency

4.1.7 Dietary energy and nutrient intake among type 2 diabetic patients

Figure 3 indicates that 75.7% of the study participants responded to the questionnaire had a pattern of three meals a day. There was no significant difference in the meal patterns of males and females.

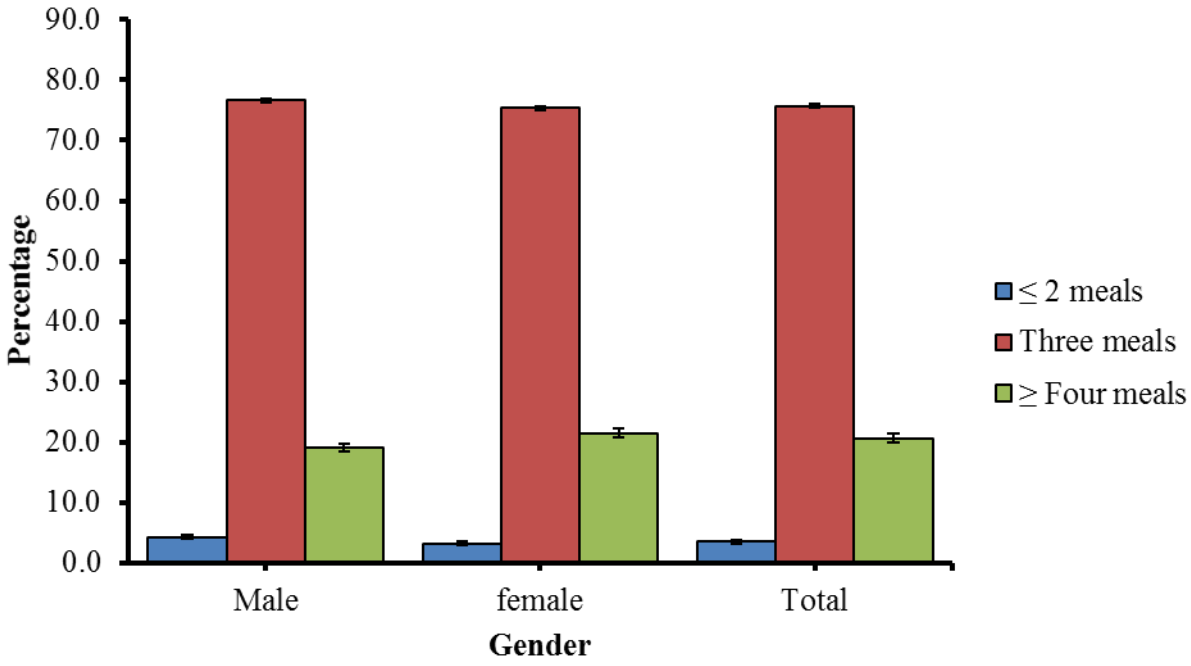

Figure 3: Patients' gender based meal intake within 24 hours

The mean intake of dietary energy, carbohydrate, dietary fiber, and magnesium was above the recommended dietary allowance (RDA) and mean dietary protein, fat and zinc were within the recommended amounts (Table 8).

Table 8: Dietary energy and nutrient intake of the study subjects (N=139)

Nutrients	Mean ± SD	RDA cutoff
Total energy (Kcal)	2036.85 ± 766.11	2036.3
Protein (%)	13.26± 6.24	15-20
Total fat (%)	30.47 ± 13.01	25-35
Carbohydrate (%)	56.33 ± 13.84	45-55
Dietary fiber (g)	49.22 ± 86.78	30-50
Calcium (mg)	551.78 ± 396.78	1000
Magnesium (mg)	442.94 ± 147.24	300-400
Zinc (mg)	8.69 ± 4.02	07-10

Results present the mean and standard deviation (SD) of the Recommended Dietary Allowance (RDA) and the cutoff points based on WHO (2006) and Nutri-survey for windows (2007).

Figure 4 indicates the percentage distribution of dietary energy, protein, carbohydrates, fats, fiber, calcium, magnesium and zinc among the study participants. Whereby, the percentage total dietary energy (55.4%), protein (64%), dietary fiber (51.8%) and calcium (86.3%) were below the recommended, carbohydrate (52.5%), total fat (36%) and magnesium (54%) were above the recommended intake and 40.3% of the participants met the RDA of zinc.

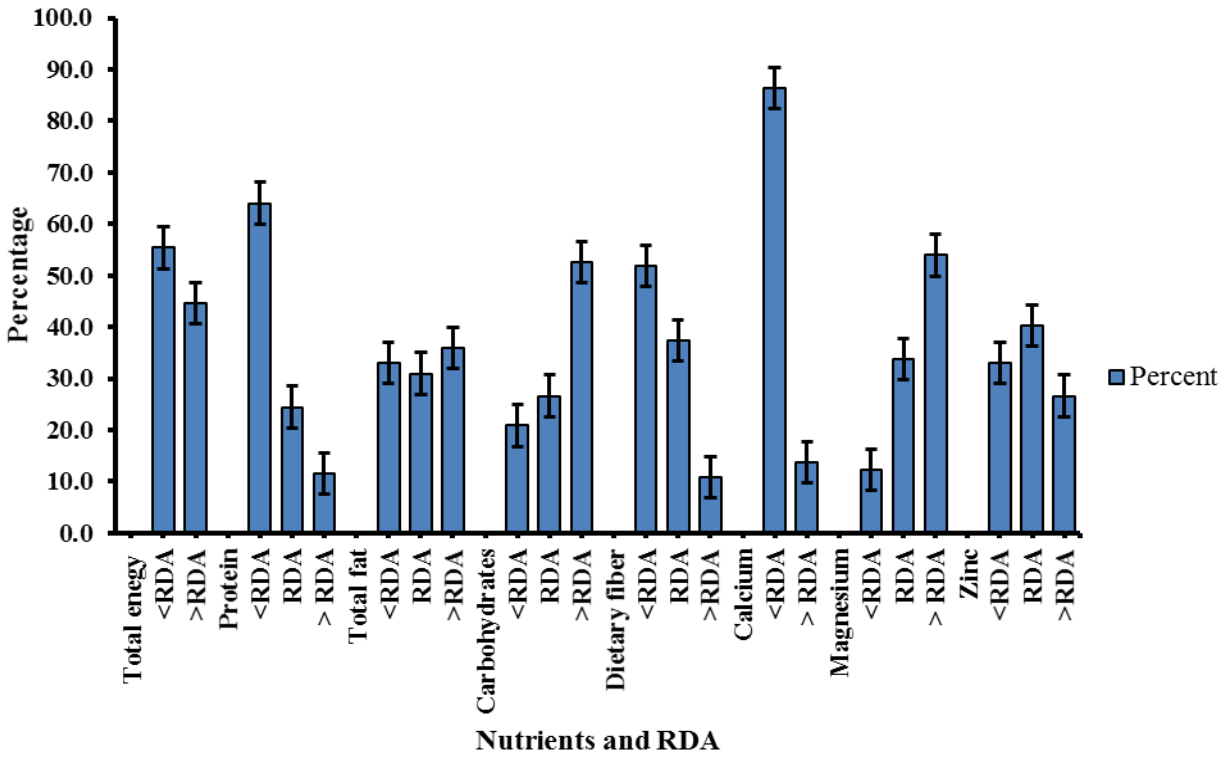

Figure 4 : Percentage dietary nutrient intake of the selected nutrients.

Table 9 indicates the correlation between BMI, WC and WHR, and the meal patterns and foods consumed by type 2 diabetic patients. The results show the extremely weak relationship which is nearer to zero.

Table 9: Correlation between meal patterns, type of foods consumed, and the anthropometric characteristics

Meal pattern and type of foods consumed	Anthropometric characteristics		
	BMI	**WC**	**WHR**
Meal pattern	0.044	-0.029	0.012
Cereal	-0.07	0.013	-0.088
Red meat	-0.061	-0.15	0.007
White meat	0.021	-0.049	-0.078
Milk	-0.022	-0.055	-0.026
Eggs	0.049	-0.031	-0.068
Leafy vegetables	-0.016	-0.031	-0.025
None leafy vegetables	0.116	0.102	0.015
Condiments	-0.016	0.056	0.09
Fruits	0.067	0.135	0.135
Sugar/sweets	-0.045	-0.035	-0.079
Roots/tuber/plantains	0.003	0.089	-0.011
Nuts/seeds	-0.023	-0.063	-0.003
Legumes	-0.015	-0.041	-0.034
Alcohol	-0.017	-0.072	-0.042
Coke	0.077	0.048	0.18
Fats/oils	0.177	0.154	0.084

BMI: Body Mass Index, WC: Waist circumference, WHR: Waist-hip-ratio, - means negative direction

Table 10 and Fig. 5 present correlation between patients' nutrient intake and their nutritional status. The significant weak association between anthropometric characteristics and intake of almost all mentioned nutrients because of r being equal to zero or nearer zero or less than 0.25, except for proteins with BMI (r=0.306). This means that nutritional status of the patients was not influenced by their dietary nutrient intake.

Table 10: Correlation matrix between anthropometric characteristics and nutrient intake by type 2 diabetic patients

Nutrients	Anthropometric characteristics		
	BMI	WC	WHR
Energy in Kcal	-0.104	-.172**	-0.162
Protein in %	.306**	0.248	.128**
Fat in %	-0.18	-.165**	-0.222
Carbohydrate in %	0.062	.058**	0.144
Fiber in g	-.147**	-0.074	.085**
Ca in mg	0.057	-.113**	0.006
Mg in mg	-0.018	-.089**	-0.041
Zn in mg	.000**	-0.057	-.138**

BMI: Body Mass Index, WC: Waist circumference, WHR: Waist-hip-ratio, Ca: calcium, Mg: Magnesium, Zn: Zinc, Kcal: Kilo calories, mg: Milligram, g: gram, %: percentage, and ** means significant at p<0.01

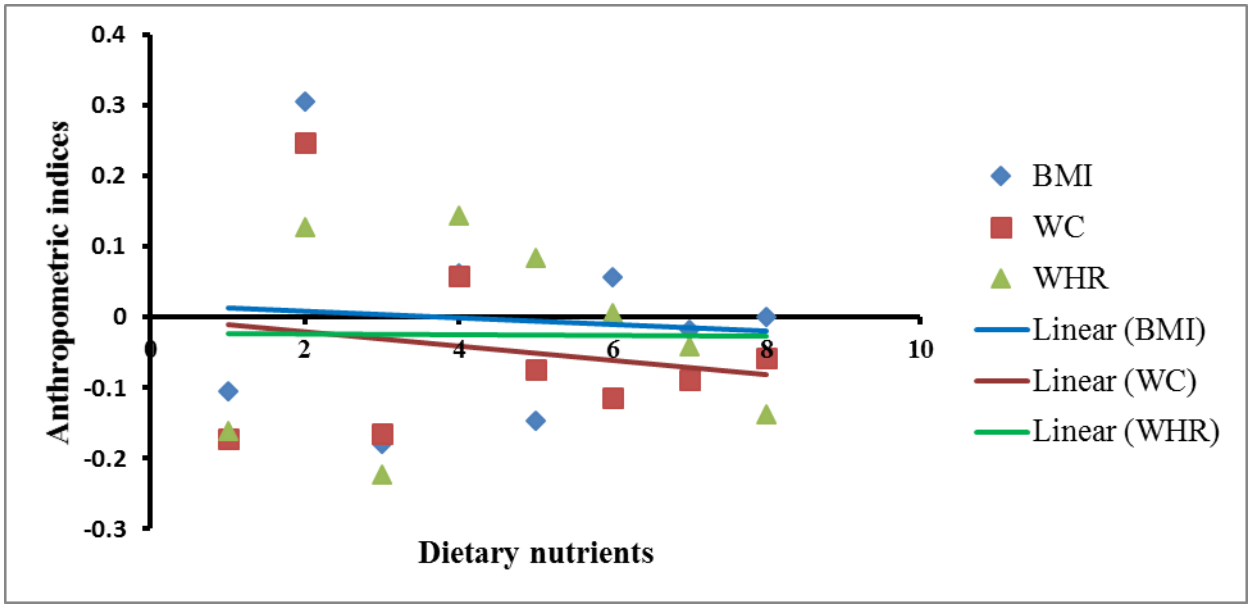

Figure 5: Correlation coefficient with linear regression lines between anthropometric characteristics (Body mass index (BMI), Waist circumference (WC), Waist-hip-ratio (WHR), and dietary nutrient intake of type 2 diabetic adults.

4.1.8 Diabetic patients' perceptions towards diabetes

This study explored the participants' perceptions in management of diabetes. Some of the participants (38.6%) perceived that diabetes is a disease like any other diseases, and 59.3% of them reported that diabetes is mainly caused by extreme intake of carbohydrate rich diet. Fifty nine percent of the participants believe that diabetes can be treated like any other diseases and most of them (67.2%) reported use of various traditional medicines as a remedy for the disease. While 58.6% of participants used both conventional and traditional treatments and 8.6% were using only traditional medicines (Table 11).

Table 11: Perceptions in management of diabetes among questionnaire, participants, N=140

Variable	n	%
Perceptions on the cause of diabetes		
Disease due to unhealthy eating	39	27.9
Inherited and life style	19	13.5
Disease like other diseases	54	38.6
Disease due to stress	12	8.6
I don't know	16	11.4
Food cause diabetes		
Carbohydrate rich foods	83	59.3
Red meat and fats	11	7.9
Alcohol and soft drinks	11	7.9
Sugar and sweets	8	5.7
No foods that cause diabetes	27	19.3
Is diabetes treatable?		
Yes	83	59.3
No	57	40.7
Treatment choice		
Conventional	46	32.9
Traditional	12	8.6
Conventional and traditional	82	58.6

Note *n*: Frequency

These results concur with what was obtained through FGD and herbalists/traditional medicines vendors, who mentioned that diabetes is an inherited disease; some think it's a result of failure of some body organs such as the pancreas and others think it's a result of high intake of carbohydrates rich diet, sugar, sweets, alcohol and fat rich foods. The majority of the informants agreed that diabetes is as a result of consumption of carbohydrate rich diet. Also, they believe that diabetes can be treated, and most of FGDs participants mentioned that the use of both conventional medicines and traditional medicines become more effective than

using conventional medicines or traditional medicines only. The following voices from FGDs are presented in tabular form in Table 12.

Table 12: Summary of focus group discussion participants' and herbalist/traditional medicines vendors' responses

Theme	Respondents	Participants' key message	Participants' remarks
Perception and understanding of diabetes	FGDs participants and local herbalists	Disease is due to lifestyle changes, particularly unhealthy eating	Lifestyle affects personal health in wide attributes
Foods that cause diabetes	FGDs participants and local herbalists	Diabetes is caused by high intake of carbohydrate rich diet, such as sugar, sweets, rice, potatoes, alcohol, coke, and foods grown with fertilizer	Diet with lot of vegetables could help to manage the disease Drinking of enough water could rule out the effect of carbohydrates and chemicals or toxins ingested through foods They contain much sugar, which cause defects in the pancreas performance
Choice of the treatments	FGDs participants	Both physician prescribed medicines and traditional medicines are used interchangeably	Most of us do that looking for diabetes treatment, and we believe that, the use of both medicines is more effective

It is clear from data collected through interviews and focus group discussion that type of food eaten and eating behavior can contribute to the development of diabetes to an individual.

One of them commented: "*Intake of carbohydrate rich diets contributes to the disease epidemic, because most of the foods we eat in town are highly processed compared to those eaten in the village, where they eat traditional foods which are minimally processed*" (FGD respondent 1: 18.05.2018)

Another participant responded:

> "*…I'm using conventional and traditional medicines at different times, for example, if I use conventional medicines during morning around 6 A.M, then traditional medicines will be at least after two hours, which is around 8 a.m. I do this in order to cure the disease*..." (FGD respondent 11: 20. 5.2018)

4.1.9 Traditional medicine sources and practices among type 2 diabetic patients

Figure 6 indicates the common traditional medicines reported by questionnaire respondents to use in management of diabetes. The frequently used traditional medicines were moringa leaves and seeds (*Moringa oleifera*) (25.2%), soursop leaves (*Annona muricata*) (11.5%), black plum barks (*Syzygium cumini*) (11.5%), okra pods (*Abelmoschus Esculentus)* (9.2%), avocado seeds *(Persea americana*) (9.2%) lemongrass (*Cymbopogon citratus*) (8%), cinnamon (5.7%) and Aloe vera (5.6%), while slight use of other traditional medicines was reported by participants.

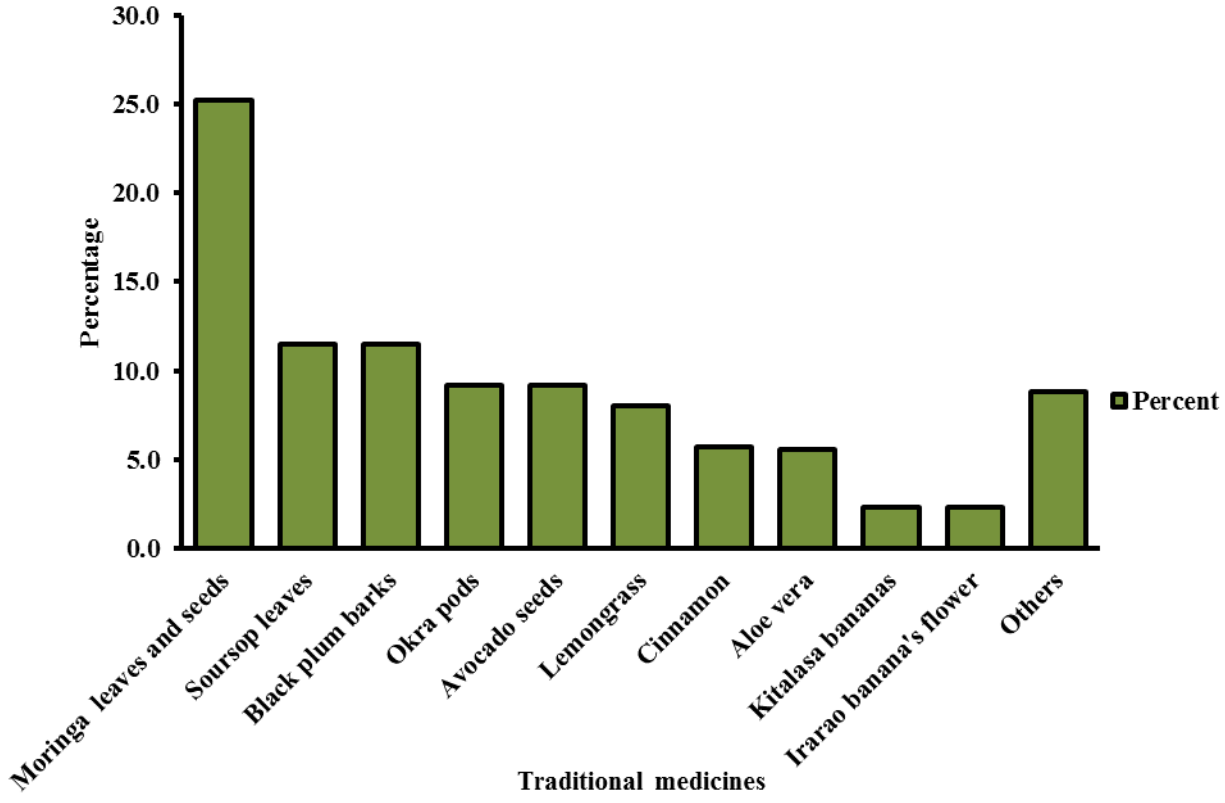

Figure 6: The percentage distribution of traditional medicine usage among diabetic patients.

Table 13 indicates traditional medicines sources and practices among diabetic patients. Thereby 35.5% of participants obtained their traditional medicines from friends, relatives and among patients. Also, 34.3% of participants were using the liquid obtained from boiling or soaking the traditional medicines in water, while 11.4% of them chewed raw seeds especially for *Moringa oleifera* seeds. The frequency of using traditional medicines was ≥2 times per day (57.9%) and 9.3% were using only when their blood glucose levels rise.

Table 13: Traditional medicine sources and practices among questionnaire, participants, N=140)

Variables	n	%
Source of traditional medicine		
Traditional medicine vendors/herbalists	44	31.4
Among patients, relatives and friends	50	35.7
Do not use traditional medicine	46	32.9
Traditional medicine preparation		
Used in raw form by chewing or making as juice	16	11.4
Dried, blended and mixed with milk, tea	30	21.4
Boiled or soaked in water and use the liquid	48	34.3
Do not use traditional medicine	46	32.9
Frequency of using traditional medicines		
Twice per day	40	28.6
Three or more times a day	41	29.3
When the blood glucose level rise	13	9.3
Do not use traditional medicine	46	32.9

Note *n*: Frequency

FGDs participants and herbalists also had similar myths that there are foods which treat diabetes. Majority of them identified certain types of vegetables such as okra pods, local varieties of green leafy vegetables such as amaranth leaves, spider plant, hare lettuce and nightshade leaves and spices like ginger, garlic and cinnamon which is commonly used as diabetes remedy. They believe that intake of large quantities of those vegetables helps to treat diabetes. Moreover, apart from vegetables they mentioned some herbs which are also believed to be useful in curing diabetes; these include Aloe vera, moringa leaves and seeds, black plum barks, avocado seeds, Vinca rosea (Rosemary flowers), bitter melon, lemon grass and soursop leaves. In most cases, these medicines are mixed with warm water, milk, tea or porridge or drank as they are, for those in liquid form. Duration of the treatment depends on the health condition of the patients.

Most of traditional medicines are found in the patients localities. Majority of FGDs participants reported that most of the traditional medicines used were obtained from the markets, neighbors, traditional medicines vendors, and some people have planted them around their homes. Herbalists mentioned that most of the medicines they use to treat diabetes are found within their environments and are prepared locally, based on experience. Consider the following data in the Table 14.

Table 14: Summary of focus group discussion participants' and herbalist/traditional medicines vendors' responses

Theme	Respondents	Participants' key message	Participants' remarks
Foods used to treat diabetes	FGDs participants and local herbalists	Intake of indigenous vegetables such as amaranths, hare lettuce, spider plant leaves, and nightshade leaves, as well as okra pods, African eggplants, ginger, garlic, cinnamon and tamarind juice	These vegetables are used as part of the meal and sometimes as diabetes dose especially for okra pods.
Traditional medicines/herbs used to treat diabetes	FGDs participants and Local herbalists	Moringa seeds and leaves, Vinca Rosea (Rosemary Flowers), bitter melon, Soursop leaves, avocado leaves, black plum barks, lemon grass and Alovera are the common plants that were used to treat diabetes	Some of the plants are very helpful in managing diabetes and other related health conditions if used properly but sometimes are not.
Sources of traditional medicines	Local herbalists	Most of the plants we use for processing drugs are obtained from forests and farms.	Generally, plants used for traditional drug preparation are locally available
	FGDs participants	Most of them obtained from our home, neighbor's homes or friends and markets	

From the data collected through interviews and focus group discussion, it is clear that Moringa seeds, okra pods, Vinca Rosea (Rosemary flowers), Tamarind juice, pumpkin, indigenous nightshade leaves just to mention a few are plants that are very supportive in rectifying diabetic problem. These have been evidenced by the following FGDs and herbalists voices;

FGDs participant stated: *"I'm using Moringa seeds and Rosemary flowers (Vinca Rosea) as a remedial solution for my diabetes problem. This has revealed to be very helpful since my blood sugar level has dropped to normal"* (FGD respondent 15: 20.5.2018)

Local herbalists reported:

> "… *We find them from herbal medicine shops found in Arusha, others are collected from farms and forest. Fruits and vegetables such as carrot, garlic, ginger, onions and cinnamon are obtained from the market. Dried Aloe Vera (Shubiri) is brought from the market because I cannot process it*..." (Local herbalist E: 23.6.2018)

4.1.10 Reasons for using traditional medicines by diabetic patients

The main reasons for use of traditional medicines were high costs of conventional medicines, availability and accessibility of traditional medicines, friend's advice and looking for effective treatment. Thirty two percent of participants decided to use traditional remedies after being convinced by friends and relatives. A substantial number of participants (55.0%) believe that, traditional medicines are the best treatment because when they use them, their blood glucose levels were better regulated. Religious beliefs, health care provider's advice, and lack of awareness on their effectiveness and specifications were among the reasons given by non-users. While those who reported to use both conventional and traditional remedies said that using both treatments improve the effectiveness, substituted the cost of conventional treatment and were also looking for the most effective treatment. Additionally, apart from using traditional medicine for diabetes treatment, patients use them in the management of other complications arising from diabetes, such as high blood pressure, eye problem, kidney problem and joint pains. High blood pressure is the leading complication that is managed with the traditional medicines along with diabetes (Table 15).

Table 15: Reasons for using traditional medicines in management of diabetes by questionnaire participants N=140

Variables	n	%
Reason for deciding to use traditional medicine		
High cost of the conventional medicines	25	17.9
Accessibility and availability of traditional medicine	24	17.1
Advised by friends and relatives	45	32.1
Do not use traditional medicine	46	32.9
Usefulness of the medicine on managing diabetes		
Lead to very low blood pressure and hypoglycemia	17	12.1
Regulate blood glucose levels	77	55
Do not use traditional medicine	46	32.9
Reason for not using traditional treatments		
Religious beliefs	13	9.3
Advice from health care providers	13	9.3
Not aware about the effectiveness and specifications	11	7.9
Do not prefer mixing the treatment	9	6.3
User of traditional medicine	94	67.2
Reason for using both Conventional & traditional methods		
More effective	28	20
Cost substitution	16	11.4
Looking for effective treatment	27	19.3
Not applicable	69	53.6
Complications treated with traditional treatment		
High blood pressure	42	30
Eye, Kidney and joint problems	18	12.9
Diabetes only	34	24.3
Do not use traditional medicines	46	32.9

Note *n*: Frequency

These findings were supported by responses from FGD participants, whereby participants declared that hospital drugs costs, accessibility and availability of the traditional medicines and advices from friends derived them to use traditional medicines. And some believe that the use of both physician prescribed medicines and traditional medicines improve efficiency. Apart from diabetes, traditional medicines believed to be effective in managing other diabetes associated complications such as wound healing, kidney problems, constipations, high blood pressure among others. For instance, Moringa seeds said to be useful in managing high blood pressure and wound healing. However, the majority of the responded that due to unclear prescription of traditional medicines sometimes they pose detrimental side effects to their body health like hypoglycemia, kidney diseases, fatigue and diarrhea among others.

Traditional medicine vendors or local herbalists also reported on the traditional medicines uncertainties in the sense that sometimes they help to treat the disease and sometimes they don't. This is associated with unclear prescriptions on how much to take, because in most cases, they advise a patient to take the medicine until the disease is treated. Additionally, FGDs and local herbalists complained that hospital medicines are not as helpful as traditional medicines in the fact that hospital medicines only bring relief but they do not completely cure diabetes. It was further substantiated by FGD respondents that the government should certify and support the use of traditional medicines as they treat many diseases which may not be treated in hospitals. Herbalists supported by giving some examples of people who were not treated in the hospital, but successfully treat by locally made medicines (Table 16).

Table 16: Summary of focus group discussion participants' and herbalist/traditional medicines vendors' responses

Theme	Respondents	Participants' key message	Participants' remarks
Influences/advices/source of information on the use of foods or traditional medicines for diabetes management	FGDs participants	High cost of conventional medicines, availability and accessibility of traditional medicines, friends, TV and radio advertisement, traditional medicines vendors/herbalists	If possible diabetes medicines should be provided for free, because some patients remain home due to lack of money.
			Community based counseling will help to make people aware of the disease and its management.
Effectiveness of traditional and synthetic drugs	Local herbalists	The effectiveness of any drug depends on the duration that the disease has existed into one body.	Any type of drug performs better in the early stages of the disease.
		Traditional medicines are more slowly in curing as compared to synthetic medicines	Cures the disease slowly and needs completion of the prescribed dosage
	FGDs participants	Traditional medicines help in the management of diabetes associated complications	They help to manage high blood pressure, eye and kidney diseases, and joint pains, wound healing among others.
Challenges and side effects faced by patients	FGDs participants	Traditional medicines, if not used effectively can lead into the negative effects or complications like diarrhea, fatigue, extreme drop of sugar level sometimes death	It is better for diabetes to be treated in hospitals using synthetic and well prescribed drugs.
		Traditional medicines are uncertain in the sense that sometimes helps to cure disease but sometimes they don't.	
		No clear prescriptions on how much the patient should take the medicines, they advised to take the medicines until the disease is cured.	Research should be done so as to have clear prescriptions and measurement on how to use them for better results
Recommendations/suggestions	FGDs participants and local herbalists	The government should recognize, certify and support the use of traditional medicines so as to provide specifications	To make a follow up on the traditional medicine sellers

From the summary above it is apparent that most of the people prefer to use traditional medicines as compared to synthetic medicines although the effectiveness of most of the traditional medicines is very slow. Also, it was expressed that some traditional medicines have negative side effects due to lack of standards and specifications on how much to use. This was verified from the FGDs and local herbalists as follows:

FGD participant said: *"Sometimes I fail to get the hospital drug due to money constrain, then I opt for traditional medicines because they are available and accessible".* (FGD respondent 4: 18.5.2018).

Another FGDs participant reported: *"Soursop leaves are good in managing diabetes, but one has to drink very little since if you drink much of it sugar extremely drops. One day I used it immediately I experienced anomalous condition".* (FGD respondent 7: 20.5.2018)

The local herbalist experience:

> *"…People are interested in using drugs for a short period of time. When it appears that patients have to use a drug for a prolonged period of time like 90 days they get bored. Traditional medicines treat slowly and require completion of the dosage within the required time..."* (Local herbalist F: 24.6.2018)

4.1.11 Association between socio-demographic characteristics and choice of treatment

Table 17 shows the association between socio-demographic characteristics and choice of treatments among the diabetic patients. Socio-demographic characteristics do not influence the choice of treatments because insignificant association. Although with absolute percentages, 76% (54/74) patients aged 41-60 years old and had the disease for more than five years were using both conventional and traditional treatments followed by those aged above 60 years.

Table 17: Socio-demographic characteristics and duration of diabetes vs treatment choice, N=140

Variables	Treatment choice			
	Conventional	Traditional	Conventional &traditional	P-Value
Gender				
Male	17 (37.0)	4 (33.3)	26 (31.7)	0.83
Female	29 (63.0)	8 (66.7)	56 (68.3)	
Age (years)				
21-40	6 (13.0)	3 (25.0)	5 (6.1)	0.05
41-60	17 (37.0)	5 (41.7)	49 (59.8)	
>60	23 (50.0)	4 (33.3)	28 (34.1)	
Marital status				
Never married	6 (13.0)	0	4 (4.9)	0.42
Married or cohabiting	30 (65.2)	8 (66.7)	64 (78.0)	
Separated or divorced	2 (4.3)	1 (8.3)	3 (3.7)	
Widow/widower	8 (17.4)	3 (25.0)	11 (13.4)	
Education				
Never went to school	0	1 (8.3)	4 (4.9)	0.61
Primary school	29 (63.0)	9 (75.0)	52 (63.4)	
Secondary school	9 (19.6)	1 (8.3)	12 (14.6)	
College/ university	8 (17.4)	1 (8.3)	14 (17.1)	
Employment status				
Formal employment	9 (19.6)	1 (8.3)	14 (17.1)	0.79
Self-employed	19 (41.3)	7 (58.3)	44 (53.7)	
Retired officer	10 (21.7)	3 (25.0)	14 (17.1)	
Unemployed	8 (17.4)	1 (8.3)	10 (12.2)	
Duration of the disease				
<1 Year	4 (8.7)	0	4 (4.9)	0.76
1-5 years	10 (21.7)	3 (25.0)	22 (26.8)	
>5 years	32 (69.6)	9 (75.0.0)	56 (68.3)	

Note *n*: Frequency. Chi-square test (95% CI, $p<0.05$)

4.1.12 Association between treatment choice with anthropometric characteristics, blood glucose levels and blood pressure

Table 18 presents findings on the association of treatment choices with fasting blood glucose levels, body mass index (BMI), waist circumference, waist-hip-ratio (WHR), and blood pressure. There is a significant association between the treatment choices and the fasting blood glucose among the patients ($p<0.05$). Majority of the conventional medicine users (84.8%) had elevated fasting blood glucose levels (≥7.0 mMol/L), followed by 66.7% of the traditional medicine users. There were no significant association between treatment choices and the anthropometric characteristics ($p>0.05$). High prevalence of obesity based on BMI and WC categories revealed among conventional medicine users. Most of the traditional medicine users were normal based on BMI, WC and WHR categories. This may indicates the efficacy of traditional medicines in the management of body weight, though sometimes may be due to the effect of age on BMI since most of the older patients were using conventional medicines and age known to influence the BMI.

Diabetes and hypertension are twin diseases because majority of the people with diabetes are also hypertensive. About 49% of patients were hypertensive. Of these 63% of the conventional medicines users were hypertensive. Most of the traditional medicine users were normotensive, although the association was insignificant ($p>0.05$). This indicates that traditional treatments had contributions on fasting blood glucose levels and high blood pressure management as claimed by patients (Table 18).

Table 18: Association between treatments used with blood glucose levels, anthropometric measurements and blood pressure

Variables	Total n (%)	Treatment			P value
		Conventional n (%)	Traditional n (%)	Conventional & Traditional n (%)	
Blood glucose levels in mMl/L)					
Normal (<7.0)	44 (31.4)	7 (15.2)	4 (33.9)	33 (40.2)	0.01
High (≥7.0)	96 (68.6)	39 (84.8)	8 (66.1)	49 (59.8)	
Body mass index (BMI) in kg/m^2					
Underweight (<18.5)	8 (5.7)	2 (4.3)	1 (8.3)	5 (6.1)	0.32
Normal(18.5-24.9)	50 (35.7)	14 (30.4)	7 (58.3)	29 (35.4)	
Overweight (25-29.9)	48 (34.3)	14 (30.4)	3 (25.0)	31 (37.8)	
Obese (≥30)	34 (24.3)	16 (34.8)	1 (8.3)	17 (20.7)	
Waist circumference (WC) in cm					
Normal (<80 in female and <94 in male)	46 (32.9)	11 (23.9)	6 (50.0)	29 (35.4)	0.13
Overweight (80-87.9 in female and 94-101.9 in male)	29 (20.7)	7 (15.2)	3 (25.0)	19 (23.3)	
Obese (≥88 in female and ≥102 in male)	65 (46.4)	28 (60.9)	3 (25.0)	34 (41.5)	
Waist-hip-ratio (WHR)					
Normal (<0.8 in female and <0.9 in male)	26 (18.6)	7 (15.2)	3 (25.0)	16 (19.5)	0.67
Overweight (0.8-0.84.9 in female and 0.9-0.99 in male)	47 (33.6)	18 (39.1)	2 (16.7)	27 (32.9)	
Obese (≥0.85 in female and ≥1 in male)	65 (47.9)	21 (45.7)	7 (58.3)	39 (47.6)	
Blood Pressure in mmHg					
Normotension (≤139/≤89)	71 (50.7)	17 (37.0)	7 (58.3)	47 (57.3)	0.08
Hypertensive (≥140/≥90)	69 (49.3)	29 (63)	5 (41.7)	35 (42.7)	

Blood pressure cut-off point (WHO, 2005), blood glucose level cut-off point (WHO, 1999a), Body Mass Index (BMI), Waist Circumference (WC) and Waist-Hip-Ratio (WHR) cut-off for adults (Male and Female) (WHO, 2000, 2011; Dalton *et al*., 2003). Association tested at 95% CI, P<0.05

4.1.13 Mineral concentration of the seven selected foods and traditional medicine used by diabetic patients

Table 19 presents the concentration of calcium, magnesium, chromium and zinc of the seven selected plants used by diabetic patients in the management of diabetes determined by EDP-XRF. All plants were found to contain all the four key elements of interest. *Annona muricata* (Soursop leaves) and *Syzygium cumini* bark (Black plum barks) are a good source of calcium and magnesium respectively, *Abelmoschus esculentus* pods (Okra pods) are a good source of *chromium and zinc and Moringa oleifera* seeds (Moringa seeds) are a good source of zinc similar to *Abelmoschus esculentus* pods (Okra pods). Based on GenStat analysis, there were significant differences in mineral contents of each medicine at $p<0.001$, but there was no statistical significant difference of chromium levels between *Moringa oleifera* leaves and seeds, and *Syzygium cumin* bark (Black plum barks) and *Annona muricata* leaves (Soursop leaves); and zinc levels between *Abelmoschus esculentus* pods (Okra pods) and *Moringa oleifera* seeds ($p>0.001$).

Table 19: Mineral contents of selected plants used by diabetic patients (mg/100g)

Scientific name (common names)	Mg	Ca	Cr	Zn
Syzygium cumini (Black plum barks)	856.00a	2070.00b	0.06d	0.45f
Abelmoschus esculentus (Okra pods)	370.70b	907.00d	0.19a	3.96a
Moringa oleifera leaves	262.00c	1999.00c	0.09b	2.57b
Moringa oleifera seeds	234.90d	307.00f	0.09b	3.98a
Annona muricata (Soursop leaves)	189.10e	3691.00a	0.06d	0.93d
Cymbopogon citratus (Lemon grass)	116.90f	515.00e	0.02e	1.77c
Persea americana (Avocado seeds)	11.05g	27.00g	0.08c	0.72e
P-Value	***	***	***	***
Mean	291.60	1359.20	0.08	2.05
CV (%)	3.10	1.20	3.40	4.50

Values with similar superscripts in a column are not significantly different from each other ($p > 0.001$). Values are expressed as mean, Ca: calcium; Mg: magnesium; Cr: chromium and Zn: zinc Values with *** indicates significant: $p < 0.001$.

4.2 Discussion

4.2.1 Nutritional status of type 2 diabetic patients in Northern Tanzania

Nutritional status of an individual influenced by various factors, including metabolic processes and physiological response of the body, as well as quality and diversification of foods (Afman & Müller, 2006; Klem, 2010). Inadequate and over-intake of foods in terms of nutritional contents and quantity consumed, exposes someone into a burden of life-threatening diseases such as diabetes, cancer, overweight/obesity and cardiovascular diseases

(Manders, 2006; Klem, 2010; Ruchugo, 2015). In the studied population majority of the patients were nutritionally poor due to high prevalence of overweight and obesity/central obesity. This might be attributed with socio-demographic characteristics of the patients which include age, gender, marital status, education levels and employment status of patients. This is because the increased prevalence of overweight and obesity/central obesity with the fore mentioned factors unveiled in this study.

Gender disparities are among the risk factor in the prevalence of malnutrition as observed in the studied population, where females were more overweight and obese/ central obesity compared to males. Several studies reported that females are at increased risk of being overweight or obese than males (Mathenge, Foster, & Kuper, 2010; Befort, Nazir, & Perri, 2012; Damian, Kimaro, Mselle, Kaaya, & Lyaruu, 2017). This might be attributed to physiological changes which occur as a result of childbearing, where most of them gain weight that enlarges their abdominal region, and if not managed after delivery continues to exist throughout their lifetime. Studies reported on the contribution of pregnancy to excessive visceral fat deposition which may lead to future metabolic effect diseases (Kinoshita & Itoh, 2006; Gunderson *et al.*, 2008).

Higher prevalence of overweight and obesity or central obesity was also unveiled in older adults than young adults. Of which patients aged 41-60 years old were overweight/ centrally obese compared to their counterpart. This means that as an individual become older increases the chance of being overweight and obese. Several studies demonstrated the increased risk of overweight and obesity with age (Cartwright, Tchkonia, & Kirkland, 2007; Janghorbani *et al*., 2007; Wang & Beydoun, 2007; Damian *et al*., 2017). Physiological and nutritional changes could influence the nutrition status of an older people, because they affect body mass compositions which result in the increased cardiovascular disease risks including diabetes (Fauziana *et al*., 2016). These physiological changes make them physically inactive in addition to poor dietary intake, which increases their fat mass in the visceral region, while decreasing the muscle mass.

Patients attending clinic at KCMC hospital were more overweight /centrally obese than those from Mount Meru hospital, which indicates that being admitted at KCMC hospital are more likely to be overweight and obese/centrally obese than those from Mount Meru hospital. Similar findings reported by Damian *et al*. (2017), who found 100% of overweight/obese patients from KCMC hospital. This might be because KCMC hospital is a zone referral

hospital, of which patients having critical diabetic complications that cannot be handled at primary and regional health facilities are referred for further investigations. Most patients at this stage are not physically active anymore due to their body weakness associated with diabetes complications.

Nonetheless, the study findings observed the contribution of education level to the nutritional status of an individual, whereby, patients with primary education were more overweight/centrally obese than other education levels. The study done in South Africa reported on the association between better education and obesity (Senekal, Steyn, & Nel, 2003). While the study done in Iran reported that less educated people are more likely to be overweight and obese (Janghorbani *et al*., 2007). Also, negative association between obesity and education levels was reported by Hajian-Tilaki and Heidari (2009), and the independent association was reported by Martín, Nieto, Ruiz and Jimenez (2008). These contrasting results could be due to knowledge variations and perceptions towards overweight and obesity. Because some may be satisfied to have large body weight, while others may not.

Moreover, marital status was one of the risk factors for overweight/central obesity development among diabetic patients. Higher prevalence of overweight and obesity observed among married/cohabiting patients. This is consistent with the results reported by previous study that, married people are more likely to be overweight and obese (Janghorbani *et al.*, 2007; Andrade, Caldas-Junior, Kitoko, Batista, & Andrade, 2012; Dinour, Leung, Tripicchio, Khan, & Yeh, 2012; Fauziana *et al*., 2016). Lifestyle and changes in dietary intake may contribute to the susceptibility to the problem, because of not being conscious with dietary need and physical activity due to the increased family responsibilities or other competing priorities. Also, may be due to morphology changes among females because of pregnancy (Kinoshita & Itoh, 2006; Gunderson *et al*., 2008).

Furthermore, employment status of an individual contributes to his/her nutritional status positively or negatively. The present study observed the high prevalence of overweight and obese among self-employed patients than their counterparts. Studies reported on the increased risk of overweight/central obesity among lower economic status, lower occupation, retired and unemployed people (Azadbakht & Esmaillzadeh, 2008; Martín *et al*., 2008). These could be attributed with lower physical activity due to aging and diabetes attributed complications, lack of weight gain control efforts and awareness on the side effects of overweight or obesity towards management of diabetes.

The presented findings unveil that, apart from other factors, socio-demographic characteristics increase the risk of overweight and obesity/central obesity among the type 2 diabetic patients.

4.2.2 Dietary practices among diabetic patients in Northern Tanzania

Dietary therapy is a cornerstone of management of diabetes because it helps to improve glycemic control. Proper eating habits improve quality of life, nutritional status and prevent diabetes attributed complications (Pastors, Warshaw, Daly, Franz, & Kulkarni, 2002). Maize based foods and green/cooked bananas were highly consumed by the patients who participated in this study. Thereby, intake of maize source foods was on daily basis and green/cooked bananas were consumed at least 3 times per week, but fewer (14.3%) patients were found to consume rice. Similar results obtained from another study, where most of the patients ate green/cooked bananas and maize source foods (Hoffmeister, Lyaruu, & Krawinkel, 2002). This could be attributed to the fact that, these are the most common staples available in these regions (Minot, 2010). Most of them consumed unrefined maize, especially stiff porridge (ugali) and maize-kidney bean dish known as makande/ngararumo/kiburu. These diets are good for the diabetic patients because of rich in protein, fibers, vitamins and minerals. But, the findings differ from what was reported in 2002, where most of the patients were consuming highly processed maize flour (sembe) and polished rice (Hoffmeister *et al.*, 2002). The improvement from consumption of highly processed to the unrefined maize flour may be attributed to the counseling provided by the health care providers during clinic visits especially at KCMC hospital.

Besides, beef, fish, milk and eggs were highly consumed by the patients, in so doing, most of them had 1-2 times per week of beef intake, while fish and whole milk were consumed on daily basis. Eggs were occasionally consumed by majority, but with intake of more than 2 eggs per meal. These results are similar to the study done in 2005 (Hoffmeister *et al.*, 2005). In fact beef is among the favorite food of the major tribes found in this zone, especially Chaga and Pare, and whole milk are used to add flavor in tea, since most of them don't use sugar. Beef and whole milk considered to be rich in saturated fat that can raise unhealthy blood cholesterol, especially LDL (Dennison, Erb, & Jenkins, 2001; Balch, 2006; Feskens, Sluik, & van Woudenbergh *et al.*, 2013; Asif, 2014). Several studies reported on the insignificant association between eggs consumption and serum cholesterol levels or coronary heart disease and type 2 diabetes (Song & Kerver, 2000; Djoussé *et al*., 2010). However, in

other studies high consumption of eggs increases the risk of type 2 diabetes and cardiovascular diseases (Nettleton, Steffen, Loehr, Rosamond, & Folsom, 2008; Djoussé, Gaziano, Buring, & Lee, 2009; Li, Zhou, Zhou, & Li, 2013). Another study reported on the beneficial effects of high egg diet in dietary management of type 2 diabetes (Fuller *et al*., 2015; Fuller *et al*., 2018). Fish consumption is advisable because of being rich in unsaturated fat, especially omega-3 fatty acid which is beneficial for health (de Deckere, 2001; Kris-Etherton, Harris, & Appel, 2002; Calder & Yaqoob, 2009). Due to that patients should be advised to reduce intake of beef and whole milk, increase consumption of fish with minimal intake of eggs.

Vegetable and fruits were consumed by most of the patients, although, they didn't reach the WHO recommendation of at least four servings/400 g per day (WHO, 2003b), most of them had at most three servings daily (during meal time). Amaranths leaves, okra pods, African eggplants and mixture of non-leafy vegetables were mainly consumed. The findings are similar to what reported in other studies (Keding, Weinberger, Swai, & Mndiga, 2007; Jordan, Hebestreit, Swai, & Krawinkel, 2013). This could be associated with the existing belief that, these vegetables help in managing diabetes. Indigenous vegetables were reported to have positive impact on diabetes management (Pieroni, Houlihan, Ansari, Hussain, & Aslam, 2007; Kunyanga *et al*., 2011). Antioxidant potential of these vegetables suppress the onset of the diseases (Bazzano *et al*., 2002; Nahak, Suar, & Sahu, 2014). Therefore, use of these types of vegetables along with other vegetables should be promoted among the patients, by increasing servings per day as recommended by WHO to help them reduce the diabetes progression and onset of complications.

Ripe bananas and avocado were among the preferred fruits by the study participants. Availability and accessibility of these fruits in the patient's locality may contribute to their high consumption. High intake of ripe banana attributed to detrimental effect on patient's health, because of high glycemic index (Foster-Powell, Holt, & Brand-Miller, 2002; Atkinson, Foster-Powell, & Brand-Miller, 2008). Though high intake of avocado fruits promote health blood lipid profile, supports cardiovascular health, weight management, and health aging (Dreher & Davenport, 2013; Maitera, Osemeahon, & Barnabas, 2014). Generally, regular intake of fruits and vegetables lower the risk of cardiovascular diseases, including diabetes and hypertension, due to high nutrients contents and fiber, low energy density and high water content (Krauss *et al*., 2000; Bazzano *et al*., 2002; Asif, 2014). Intake

of five or more servings of fruits and vegetables per day as meal and snack are strongly advised because of their potential benefits.

High consumption of kidney beans and groundnuts was seen among study participants. Kidney beans consumption linked to healthier eating patterns, favourable weight outcomes, reduction in BMI and waist circumference (Papanikolaou & Fulgoni III, 2008; Pereira, Felix, Mattei, & Fisberg, 2018). Nuts are rich in fibers which promote satiety and weight reduction by decreasing energy intake (Ros & Mataix, 2006; Salas-Salvadó *et al.*, 2006). Regular consumption of nuts associated with improvement in lipid profile because of total and LDL cholesterol reduction (Salas-Salvadó, Bullo, Perez-Heras, & Ros, 2006; Kris-Etherton, Hu, Ros, & Sabate, 2008; Li *et al*., 2009; Ros, 2015). Thus, high consumption of beans and groundnuts observed among type 2 diabetic patients might be potential for management of diabetes and its complications, and improving insulin sensitivity.

Nevertheless, alcohol and soft drink intake were revealed among the patients. More than fifty percent of them found to use soft drinks (coke) and 27.9% were consuming alcoholic drinks (Beer). Alcoholic and soft drinks intake is linked to the excessive body weight gain (Ludwig, Peterson, & Gortmaker, 2001; Sichieri, Trotte, de Souza, & Veiga, 2009; Bezerra & Alencar, 2018). Excess weight gain is among the risk factor for diabetes development. Also, excessive soft drink beverage consumption associated with fatty liver (Assy *et al*., 2008; Abid *et al*., 2009). Intake of less than two drinks per day is recommended (WHO, 2003b; Asif, 2014). Therefore, type 2 diabetic patients should be advised to minimize the intake of alcohol and soft drink beverages to attain lower blood glucose levels and reduce effects of diabetes related complications.

More than eighty percent of participants participated in this study through questionnaires were using sunflower oils. Similar findings reported in previous studies (Hoffmeister *et al.*, 2002; Hoffmeister *et al.*, 2005). Health care providers advise diabetic people to replace the use of animal fats with vegetable oils (as presented also in their clinic cards), or is due to the availability and accessibility at affordable price. In fact, most of vegetable oils including sunflower oils are rich in unsaturated fats, especially polyunsaturated fatty acids and advisable for health because of the lower total blood cholesterol, although excess intake may lower even the good cholesterol (HDLs) (Balch, 2006). Therefore, use of sunflower oil should be encouraged among the type 2 diabetic patients in the studied population with precaution on the burden of their excess intake.

Intake of three meals a day was observed among majority of the study participants, which contrasting the results obtained by Hoffmeister *et al*. (2002), where most of the patients had more than four meals a day. However, similar intake of three meals a day was reported in a study conducted among French adults (Bellisle *et al*., 2003). It is advised for a diabetic patient to take more than three meals a day (at least three main meals and snack in between meals) or taking small portions per meal several times (Asif, 2014), to prevent hypoglycemia, and sometimes hyperglycemia due to intake of large portion size at once. ADA (2016) insisted on healthful eating pattern with diversified nutrient-dense foods in appropriate portion size, that will maintain body weight, optimal glycemic control, lipid, blood pressure and avert diabetes attributed complications. Intake of three meals a day might be attributed to income constraints and life expenses due to urbanization.

In addition to that, the majority of patients had low intake of energy, carbohydrates, dietary fiber and calcium, while high intake of protein, total fat and magnesium. American Diabetic Association reported on the association between low energy intake and increased protein requirements attributed with conversion of dietary protein to glucose (ADA, 2002). Therefore, lower dietary energy and protein intake observed in the study may increase protein requirements in the body and end-up in protein malnutrition. However, low protein diet attributed with improvement on progression of diabetic nephropathy by retarding the decline of glomerular filtration rate (Hansen, Tauber-Lassen, Jensen, & Parving, 2002). Intake of high fiber diet help to mitigate cardiovascular diseases, risk of hyperglycemia, hyperlipidemia and obesity through modulation of food ingestion, digestion, absorption and metabolism (Anderson *et al*., 2009; Kaczmarczyk, Miller, & Freund, 2012). Emphasis on increasing consumption of dietary fiber source foods to the patients is of paramount importance.

Mazengo reported high intake of total carbohydrates (74-79%) among diabetic patients (Mazengo, Simell, Lukmanji, Shirima, & Karvetti, 1997), which differ from results obtained in the present study where the mean carbohydrates intake was 56.33± 13.84%. This might be associated with restriction in refined grains, sugar and sweets, alcohol and soft drinks intake, because of the associations with diabetes. Excess intake of dietary carbohydrates is deposited as fat in the adipose tissues which contribute to overweight and obesity (Willett, Manson, & Liu, 2002), as the major risk factors of diabetes development and/or progression, because of the defaults posed in the insulin sensitivity. In addition to that, high dietary fat intake

increases adiposity and obesity (Astrup, Grunwald, Melanson, Saris, & Hill, 2000; Garcia-Lorda, Rangil, & Salas-Salvado, 2003). However, correlation coefficient analysis results indicate weak relationship between the nutritional assessment indices (BMI, WC and WHR), dietary patterns and nutrient intake regardless of the reports demonstrated in various studies that, dietary intake may contribute to weight gain (Chaput *et al*., 2009). Probably, overweight and obesity/central obesity existing among the patients in the studied population is not attributed to dietary practices, but might be because of being physically inactive associated with diabetes complications they do suffer.

Studies demonstrated the benefit of high dietary intakes of calcium in reduction of obesity, diabetes and insulin-resistance syndrome risks (McCarty & Thomas, 2003), assist in weight and fat loss from the trunk region (Zemel, Thompson, Milstead, Morris, & Campbell, 2004), and reduction of osteoporosis risk (Nguyen, Center, & Eisman, 2000).Therefore, low intake of dietary calcium as observed in the present study may lead into obesity, diabetes progression, and osteoporosis cases among diabetic patients.

Hyperglycemia and duration of diabetes reported to be a risk factor for the plasma magnesium concentration deficiency, which indicates that being diabetic predispose an individual into magnesium deficit (Garland, 1992; Swaminathan, 2003). Also, the magnesium deficit linked to a number of diabetic complications such as cardiovascular risks and retinopathy (Garland, 1992). Therefore, over intake of dietary magnesium could help to supplement the deficit occurred which altered by the excessive urination as one of the diabetes signs. The intake of nutritive foods and traditional medicines used in the management of diabetes may supplement the deficit of the nutrients occurred in the body.

4.2.3 Food related myths, use of traditional medicines, perceptions and practices in management of diabetes

Diabetes is a complicated health condition with multiple cause and ways of management, and it is accompanied with various myths and perceptions. Myths can exist in a certain population due to lack of knowledge and awareness of the disease which block people's mindset. To eliminate that there is a need of finding out what the existing myths and educate people based on what they believe and what will be the best way of managing the disease.

The present study focused on the food related myths and the use of traditional medicines in management of type 2 diabetes. Various myths that range from the causes to the treatment of

the disease were discovered. Regarding the cause of type 2 diabetes, most of the study participants perceived that diabetes is due to the intake of carbohydrate rich diets. These findings are similar to what was found by Rai and Kishore (2009), where sugar was considered to be the cause of diabetes. Carbohydrates should be removed in the diabetic diet is among the reported patients' misconception (Rajkumar-Patil, Datta, & Boratne, 2013). In fact these might be wrong because carbohydrate being a risk factor for diabetes development depend on several factors including how much, and type/form of carbohydrate diets you consumed. It is reported that overconsumption of simple carbohydrates, such as fructose and glucose increase lipid deposition in the liver and muscles, and reduce insulin sensitivity (Lê *et al*., 2009; Sock *et al*., 2010; Lecoultre *et al*., 2013). Refined grains are mainly considered to be rich in simple carbohydrates which absorbed rapidly, and raise up blood glucose level soon after a meal, and contain insufficient amount of other nutrients such as fibers, proteins, vitamins and minerals (Balch, 2006; Babu, Subhasree, Bhakyaraj, & Vidhyalakshmi, 2009; Asif, 2014). Due to that it is advised to increase intake of whole grains to alleviate the problem, because of its lower glycemic responses (Panlasigui & Thompson, 2006; Mohan *et al*., 2014).

Along with the fore mentioned myth on carbohydrates, rice was not a preferred food by the majority, whereby only 14.3% of participants were consuming rice. This could be attributed to the existing belief that rice raises blood sugar level because of high carbohydrate content as alluded during interview. They believe that soaking in water or washing/rinsing several times or boiling a little bit and decanting the water could remove carbohydrates. However, it is impossible to remove carbohydrates from food because of its insolubility in water; instead this practice will wash out other important nutrients like fiber, vitamins and minerals, as a result of the increased glycemic index. It is possible that rice raises blood glucose levels if consumed abundantly because of its glycemic index that ranges from 68 to 73 (Foster-Powell *et al*., 2002; Atkinson *et al*., 2008). A study done in Sri Lanka indicated that rice may lead to high glycemic response if consumed in large portion size (Hettiaratchi, Ekanayake, & Welihinda, 2009). White rice consumption attributed to the increased risk of type 2 diabetes (Sun *et al*., 2010; Hu, Pan, Malik, & Sun, 2012).

We always need carbohydrates as a major source of energy for the body's cells and brain (Balch, 2006; McCrimmon, Ryan, & Frier, 2012; Mergenthaler, Lindauer, Dienel, & Meisel, 2013; Bordier, Doucet, Boudet, & Bauduceau, 2014; E González-Reyes, Aliev, Avila-

Rodrigues, & Barreto, 2016). Due to that there is no way to escape from consumption of carbohydrate source foods because can lead to diabetes, but what matters is the choice of the type of carbohydrate source foods to consume. Consumption of whole grain as a source of carbohydrates is advisable than refined grains because of lower glycemic responses that help on dietary management of diabetes and hyperglycemia (Panlasigui & Thompson, 2006; Mohan *et al*., 2014). Therefore, awareness creation on when carbohydrates considered bad and their importance to the body's cells and organs is required.

Another myth was based on the treatment of type 2 diabetes, where most of the study participants believed that, diabetes can be treated with traditional medicines. Similar to the other studies findings (Xie, Zhao, & Zhang, 2011; Perera & Li, 2012; Rajkumar-Patil, Datta, & Boratne, 2013). Most of the used vegetables and traditional medicines have been reported in various studies as medicinal plants for treatments of various ailments including diabetes (Keding *et al*., 2007; Saravanan & Pari, 2008; Adeyemi, Komolafe, Adewole, Obuotor, & Adenow, 2009; Alhassan *et al*., 2012; Nambiar, 2012; Ezejiofor, Okorie, & Orisakwe, 2013; Gemede, Ratta, Haki, Woldegiorgis, & Bet, 2014; Maitera *et al*., 2014; Valdez-Solana *et al*., 2015; Thorat, Sawate, Patil, & Kshirsagar, 2017). Sixty seven percent of type 2 diabetic patients in this study reported to use them as remedy for diabetes and related complications such as high blood pressure, wounds, eyes and kidney problem. Similarly reported by Lunyera *et al*. (2016) and Mwanri *et al*. (2018). Presence of secondary metabolites, and phytochemicals act as an antioxidants to prevent onset of chronic diseases like diabetes (Mensah, Okoli, Ohaju-Obodo, & Eifediyi, 2008; Gupta & Prakash, 2009; Udenta, Obizoba, & Oguntibeju, 2014).

Moreover, effectiveness, availability and accessibility of traditional medicines, cost of conventional medicines, friends and relatives were among the driving forces of using traditional medicines. These findings are similar to those reported in various studies (WHO, 2005; Bandaranayake, 2006; Cameron, Ewen, Ross-Degnan, Ball, & Laing, 2009; Rutebemberwa *et al*., 2013; Lunyera *et al*., 2016). Another study observed that patients were convinced to use herbal medicines because of free choices of service providers especially practitioners, and positive results from friends and relatives (Parle & Bansal, 2006). Besides that, limited knowledge on the potential adverse effects, effective therapy and rational use is still challenging, regardless of the promising results on disease control, management and treatment (OMS., 2002).

The safety of the traditional medicines is a big concern among people and the responsible authorizes worldwide, because of unlicensed or not certified practitioners, as well as self-service (Kasilo & Trapsida, 2011; Raynor, Dickinson, Knapp, Long, & Nicolson, 2011). It was reported by the patients that in case of sufferings, some of them, they just find the traditional medicines from bushes around their home, as well as from local herbalists, friends and relatives. The study participants reported that, traditional medicines are safe because they have no chemicals. The notion of no chemicals in traditional medicines also unveiled in other studies (Hussin, 2001; Kelly *et al*., 2005). However, plants contain natural chemical substances of which some are toxic and others not toxic (Liener, 2012). Unclear specifications/standards and toxicity of the traditional medicines were some of the factors that convinced some of the patients to consider them as not safe. They attribute the medicines with damaging effect of body's organs such as kidney and liver along with other complications including hypoglycemia, diarrhea, joint pains, and body weakness among others. Literatures reported on the unfriendly effects of herb medicines that considered as life-threatening or cause of premature deaths among patients (Ernst, 2002; Ekor, 2014; Abdul *et al*., 2018). Hussin (2001) reported on the number of cases associate with traditional medicines adverse effects in Malaysia, attributing the adverse effect with presence of heavy metals as well as multiple of active ingredients found in the traditional medicines.

Along that, Kaufman, Kelly, Rosenberg, Anderson, and Mitchell (2002); Adams, Sibbritt, Easthope, and Young (2003); Bush *et al*. (2007) and Armstrong, Thiebaut, Brown, and Nepal (2011) reported on the use of both conventional and traditional medicines among their participants. These findings are parallel to the present study results, of which the use of both traditional and conventional medicines dominated the group, with fewer users of traditional medicines only. This could be attributed to the beliefs that use of both medicines is more effective. However, some reported that they do so to substitute the cost in case of failure to access conventional medicines due to income constraints. However, use of herbal/traditional medicines along with conventional medicine may compromise the safety and efficacy of the treatments due to the interactions that may occur (Hussin, 2001; Pal & Shukla, 2003; Dham, Shah, Hirsch, & Barnerji, 2006; Izzo & Ernst, 2009; Ghosh, Ghosh, Kundu, & Mandal, 2018). These interactions may lead into anomalous effects as reported by some of the FGDs participants, which may end up to premature deaths. Bush *et al*. (2007) reported on the hypoglycemic effect and hypertension as herb-drug interaction adverse effects among patients who took traditional medicines known as Nepal and ginkgo with metformin or

glyburide, and hydrochlothiazive respectively. In that way, awareness creation of harmful effects, potential benefits and the way forward regarding the use of traditional medicines is of importance to the community.

The present study didn't find the association between socio-demographic information with the treatment choices, though with age there is some sort of association because of p=0.05. Absolute percentage indicates that as age increases predispose people to use alternative medicines. Similarly results found in other studies where older adults were the most users of complementary and alternative medicines (Barnes, Bloom, & Nahin, 2008; Armstrong *et al*., 2011). This could be because elders/older adults explored the world enough so they know varieties and health benefits of traditional medicines. However, contrary results reported that young and middle age are the major users of alternative medicines (Lin *et al*., 2005; MacLennan, Myers, & Taylor, 2006; Robinson, Chesters, & cooper, 2007; Xue, Zhang, Lin, Da Costa, & Story, 2007; Bahhotmah & Alzahrani, 2010). Also the present study didn't find a significant association between gender, marital status, employment, income and duration of the disease with treatment choices. The same applied to some studies which didn't find significant association between use of traditional medicines and socio-demographic characteristics of patients (Rajkumar-Patil *et al.*, 2013). Although, various studies demonstrated the significant association between higher education, income, marital status and gender and the awareness of diabetes (Ezeome & Anarado, 2007; Barnes *et al*., 2008; Bahhotmah & Alzahrani, 2010; Sharaf, Naeem, Mohaimeed, & Sawaf, 2010; Jane-lovena, Okoronkwo, & Ogbonnaya, 2011).

There was a significant association between the choice of treatments and blood glucose level regulation ($p<0.05$), and most of the patients who were using traditional medicines found to have normal fasting blood glucose levels. Several studies reported on the efficacy of the traditional medicines on improving insulin action and sensitivity by increasing glucose uptake (Qin *et al*., 2003; Yin, Zhang, & Ye, 2008; Prabhakar & Doble, 2011; Valdez-Solana *et al*., 2015; Hajra *et al*., 2016). This may explain the blood glucose regulation action of the traditional medicines as witnessed by traditional medicines vendors/local herbalists participated in this study.

On the other hand, traditional medicines seem to be useful in weight management because fewer traditional medicine users were obese as compared to conventional medicine users, but the association was statistically insignificant ($p>0.05$). However, some studies noted the

weight gain in diabetic rats (Saravanan & Pari, 2008; Alhassan *et al.*, 2012). In addition to that, traditional medicines shown to perform better on blood pressure management, because most of the traditional medicine users had normal blood pressure than conventional medicine users, though the association was insignificant (P>0.05). This is supported by various studies which documented the efficacy of traditional medicine in lowering blood pressure (Nwokocha *et al*., 2012; Lunyera *et al*., 2016). Along with high blood pressure and blood glucose level regulation some animal based studies demonstrated the hypoglycemic effect of some medicinal plant extracts in parallel with weight gain (Alhassan *et al*., 2012; Ezejiofor *et al*., 2013). Conversely, some studies reported on the weight loss associated with the use of traditional medicines that suppress appetite, and enhance glucose uptake (Nagao, Hase, & Tokimitsu, 2007; Mooney *et al*., 2008; Astell, Mathai, & Su, 2013; Parvinroo, Zahediasl, Sabetkasaei, Kamalinejad, & Naghibi, 2014; Esteghamati, Mazaheri, Rad, & Noshad, 2015). Thus, awareness creation on the harmfulness and potential benefits of the traditional medicines is of importance. Also, use of traditional medicines should be accompanied with physical activity and proper diet to prevent excessive weight gain.

4.2.4 Mineral contents of the selected traditional medicines

Most of the plants may offer dual function as medicinal and nutritive values due to their natural products contained in them. Minerals are among the natural constituents of medicinal plants which are present in small amount but contain a therapeutic function. Mineral contents of the traditional medicines used by diabetic patients to manage their diabetes varied from one plant to another. Some are good source of certain type of mineral, while poor source of another mineral. Literatures indicate that mineral composition depends on the geographical area where plant cultivated including environmental factors such as air, water and the soil (Vesk & Allaway, 1997; Valdez-Solana *et al.*, 2015). This may explain the variation that occurred in the analyzed samples when compared to other studies especially for Moringa leaves and seeds, Okra pods, lemon grass and Soursop leaves. The levels of calcium, magnesium, chromium and zinc were varying from one study to another in comparison to the present study.

The levels of magnesium, calcium and zinc in *Moringa oleifera* seeds in this study were higher than those reported by Sodamade, Owonikoko and Owoyemi (2017), but the levels of calcium and magnesium in *Moringa oleifera* leaves were equivalent to those reported by Valdez-Solana *et al.* (2015). Equivalent level of calcium with less magnesium in lemon grass

as compared to those reported by Godwin *et al*. (2014) was noted, but very higher calcium, magnesium and zinc levels with lower chromium levels than those reported by Anal (2014). The researcher noted higher levels of calcium and low magnesium, and equivalent level of zinc in Soursop leaves compared to those reported by Usunomena and Paulinus (2016). Roy, Shrivastava and Mandal (2014) and Gemede, Haki, Beyene and Woldegiorgis (2016) reported lower levels of calcium, magnesium and chromium, and higher level of zinc in okra pods than the levels obtained in the present study. There was limited chromium report in most of the studies, although the present study noted the presence of chromium in each of the studied plant parts.

Several studies documented the importance of calcium in the body's metabolism, and prevention of osteoporosis (Valdez-Solana *et al*., 2015). Magnesium attributed with prevention of cardiovascular diseases, insulin insensitivity and diabetes, zinc is important in wound healing, carbohydrate metabolism, synthesis of testosterone and possess scavenging effects on Reactive Oxygen Species (ROS) produced in the testicular tissues (Mlitan, Sasi, & Alkherraz, 2014; Valdez-Solana *et al*., 2015; Obembe & Raji, 2018). Chromium is attributed with reduction of insulin resistance or increased insulin sensitivity and improvement of fasting and glucose tolerance (Hajra *et al*., 2016). The presence of these minerals in selected plants used by diabetic patients may potentiate them to be diabetes remedy as revealed in various animal based studies. However, the results cannot warrant the confirmation that the studied traditional medicines are useful due to the presented minerals, because of the other bioactive compounds/phytochemicals that may be more effective than minerals in managing diabetes. The present results give preliminary/baseline information, which need more research to be done on other bioactive compounds and their efficacy at cellular level.

This study had some limitations. Apart from the 8 traditional herbalists, all the participants had diabetes and were attending diabetic clinics at the specialized referral hospitals, without including diabetic patients attending primary health care facilities and who were not in health care facilities while they are likely to be even greater user of traditional medicines as some of them do not use conventional medicines. Due to this, the findings might not be representative of all diabetic patients in Northern Tanzania. Also, the results may have some biasness because fewer male than female participants (33.6% versus 66.4%). This sex imbalance is due to the relatively small number of men attending the diabetic clinic at the selected hospitals. Social desirability bias was also observed because participants were recruited in a

medical setting, this may have influenced participants to under-report their use of traditional medicines and to respond to questions in a manner that may thought they would be approved of.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Alternative medicines use is prevalent among the diabetic patients. Most of the study participants believe that diabetes can be treated by using alternative medicines including traditional medicines. Some had myths towards certain foods that cause diabetes, this made some of them to have fairly good dietary practices. Most were found to have poor nutritional status as most participants were overweight or obese/centrally obese. Majority of the patients used traditional medicines in combination with conventional medicines provided at the clinic believing that will improve their blood sugar levels.. The presence of minerals like calcium, magnesium, chromium and zinc has positive effects in diabetes management in all priority foods or traditional medicines studied in this research. Use of traditional medicines in management of type 2 diabetes may be good, but requires further research to establish dosage and any interactions with conventional medicine.

5.2 Recommendations

Based on the findings of this study, the following recommendations are made for policy, practice and further studies:

(i) Periodic community-based nutrition education is important to improve nutritional knowledge, dietary practices and finally health of diabetic and non-diabetic patients'.

(ii) Awareness creation on the potential harm and/or benefits of traditional medicines in management of diabetes

(iii) Having diabetes program is highly encouraged to help deal with the food related myths and the used traditional medicines in management of diabetic patients by promoting the good myths and discouraging the bad ones.

(iv) Further study should be conducted to determine other bioactive compounds or phytochemicals and the rationale of the medicines at cellular levels. This will help to individualize the treatment for better management

(v) The government should recognize traditional medicine vendors and local herbalists so as to make follow up on the standards and specifications of their products to safeguard users from traditional medicines complications which may emerge.

(vi) More research to be done on traditional medicines to strike a balance, especially on the use of both conventional and traditional medicines.

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APPENDICES

Appendix 1: Questionnaires

Questionnaires on investigating the food myths and their complications on management of diabetes

S/N	Section A: General information	Fill blanks/Tick where appropriate		
1	Interviewers name			
2	Center Name	KCMC	1	
		Mount Meru	2	
3	Name of respondent			
4	Respondent contact			
5	Sex	Male	1	
		Female	2	
6	Date of interview			
7	Consent has been obtained	Yes	1	
		No	2	
Section B: Demographic information				
8	Please, can you tell me your age or date of birth?	Date ----------	Years	-----
9	What is the highest level of education you have attained?	Never went to school	1	
		Primary school	2	
		Secondary school	3	
		college/university	4	
10	What is your marital status	Never married	1	
		Married	2	
		Separated	3	
		Divorced	4	
		Widowed	5	
		Cohabiting	6	
		Refused	99	
11	What is your employment status?	Formal employment	1	
		Self employed	2	
		Student	3	
		A home maker	4	
		Retired officer	5	
		Unemployed	7	
		Disabled	8	
		Others (mention)	9	------- -------
12	Please, specify, your main work			
13	What is your average income per month?	<250,000	1	
		250,000-450,000	2	
		500,000- 750,000	3	
		800,000-1,000,000	4	
		>1,000,000	5	
		Refused	99	
14	What is your family size?	<3	1	
		3-5	2	
		≥6	3	
15	What is your religion?	Christian	1	
		Non-Christian	2	
		Nonbelievers	3	
16	Where do you live?	Street/village		
		Ward		

		District		

Section C: Food myths, practice and perceptions towards foods used on treatment of diabetes				
17	What do you perceive/understand about diabetes?	Inherited disease	1	
		Spiritual/supernatural punishment	2	
		Normal disease like others	3	
		Life style disease	4	
		Disease due to stress		
		Others (specify)		
18	Is it curable?	Yes	1	
		No	2	
19	If yes, which treatment can treat/cure diabetes?	Hospital based	1	
		Traditional based	2	
		Both treatment	3	
		Others (specify)		
20	If it is traditional based treatment what kind of things can be used to cure diabetes? **Mention**			
21	Is there anything that you believe when eaten/used may control blood glucose level? (**if no go to question 23 and 24)**	Yes	1	
		No	2	
22	If yes, mention			
23	If not have you ever used anything to control blood glucose level **(if no go to question no.33 then 36….)**	Yes	1	
		No	2	
24	If yes, which kind of things did you use? **(mention)**			
	Can you tell me why did you decide not to use the things anymore?			
25	Where do you get those things?	Health care providers	1	
		Medicinal food sellers	2	
		Traditional healers	3	
		Others (specify)		
26	In which form did the treatment provided?	Raw leaves/fruits/roots/seeds	1	
		Powder	2	
		Liquid	3	
		Others(specify)		
27	How are they prepared?	Eaten raw	1	
		Dried, blended and mixed with tea or used as tea leaves	2	
		Mixed with other foods	3	
		Boiled in water	4	
		Soaked in water	5	
		I don’t know	88	
		Others (specify)		
28	How many times do you use the product per day?	Once per day	1	
		Twice per day	2	
		Three times	3	
		Only when blood glucose level rise	4	
		Others (specify)…		
29	How much do you think helped you to control blood glucose level?	Very helpful	1	
		Helpful	2	
		Not helpful	3	

		Others(specify)		
30	Reason for either the answer (**Qn no.29)**	Very high blood glucose level	1	
		Blood glucose level lowered a little bit		
		Low blood glucose level(hypoglycemia)	2	
		Blood glucose level came normal/regulated	3	
		High blood pressure	4	
		Low blood pressure	5	
		Extremely weight lose	6	
		Others (specify)		
31	Why did you decide to use traditional treatment?	High cost of the hospital based treatment	1	
		Traditional treatment has less cost and very helpful	2	
		Due to culture and norms	3	
		Others (specify)		
32	Who advised you to use those foods/products/traditional treatments?	Family members	1	
		Friends	2	
		Health care providers	3	
		Others (specify)		
33	If you are not using any traditional treatment, give reason (s)	Religious beliefs	1	
		Personality	2	
		Not useful	3	
		I don't know	88	
		Others (specify)		
34	If you are using both hospital based and traditional treatments, give reason (s)	More effective	1	
		Cost reduction	2	
		I don't know	88	
		Others (specify)		
35	What is other diabetes complications treated with foods/products/any other treatment mentioned? (mention food/product and complication treated)			
36	Have you ever prescribed with a special diet by health care providers?	Yes	1	
		No	2	
37	If yes, which foods have you advised to use?			
38	Do you adhere with the advice?	Yes	1	
		No	2	
39	If not, give reason (s)			
40	Are there any foods that you believe to be a cause of diabetes?	Yes	1	
		No	2	
41	If yes, mention	Carbohydrates	1	
		Meat and meat products	2	
		Fish and poultry	3	
		Milk and milk products	4	
		Fruits and vegetables	5	
		Fats/oils	6	
		Others (specify)		
42	Why do you believe that it cause diabetes?			
43	Are there any foods that you have restricted to consume	Yes	1	

	because of your condition?	No		
44	If yes, mention and give reasons for restriction? (**if any**)			
45	Are there any foods do you eat because of your condition?	Yes	1	
		No	2	
46	If yes, mention			
47	What do you recommend on the use of those foods/any treatment do you use?			
Section D. Blood glucose				
48	When did you diagnosed for diabetes?	< 1 year	1	
		1-5 years	2	
		> 5 years	3	
49	Which type of diabetes do you have?	Type 1 diabetes	1	
		Type 2 diabetes	2	
50	What the trend of your blood glucose level after diagnosis?	First diagnosis		
		Second visit		
		Third visit		
		Fourth visit		
Section E: Anthropometric measurements				
51	Weight			
52	Height			
53	Waist			
54	Hips			
55	Pressure			

Section F: 24 hours dietary recall (list all foods and amounts eaten within 24 hours, method of preparation, time, place and the ingredients used to make the foods) including one weekend.

Time	Place	Description of foods	Preparation methods	Ingredients used	Amount	Amount in g	Code

Note: Make sure you ask whether it was a normal eating day or there was an event.

Section G: Food Frequency questionnaire (indicate the frequency of consuming the following foods by numbers eg. If you eat maize products two times per day you write 2 and if you rarely or never eat (put √)

Food item	Frequency of consumption					Average Amount consumed (per meal)	Major source (1=own production 2=purchase 3= remittance 4=others-specify)
	Per day 1,2,3-----	Per week 1,2,3----	Per month 1,2,3-----	Rare √	Never √		
Cereals							
Maize							
Sorghum							
Finger millet							
Wheat							
Rice							
Others(Specify)							
Roots, tubers, plantain							
Cassava							
Sweet potatoes							
Round potatoes							
Yams							
Green bananas							
Others (Specify)							
Legumes							
Beans							
Peas							
Cowpeas							
Pigeon peas							
Green grams							
Chickpeas							
Soybeans							
Bambara nuts							
Others (specify)							
Nuts and seeds							
Groundnuts							
Coconut							
Cashew nut							
Other seeds (specify)							
Meat, poultry, fish, eggs							
Cow-beef							
Liver							
Other organ meats							
Goat							
Pork							
Wild game meat							
Poultry-chicken/duck							
Eggs							
Fresh-water fish							
Sea fish							
Dried fish							
Sardines							
Others (Specify)							

Oils and fat							
Sunflower oil							
Palm oil							
Korie, safi,							
Butter							
Others(specify)							
Vegetables							
Cabbage							
Amaranth leaves							
Sweet potato leaves							
Cassava leaves							
Cowpea leaves							
Pumpkin leaves							
Okra							
African egg plant							
Egg plant							
Others (Specify)							
Milk and milk products							
Cow's milk (whole)							
Goat's milk (whole)							
Processed & packed milk							
Yoghurt							
Others (Specify)							
Fruits							
Citrus e.g oranges							
Mangoes							
Passion fruit							
Water melon							
Bananas							
Pineapple							
Papaya							
Avocado							
Wild fruits (baobab, tamarind etc)							
Others (Specify)							
Beverages/Drinks							
Local beer							
Beer							
Konyagi							
Soda							
Coffee							
Tea with tea leaves only							
Milk tea							
Others (specify)							

Checklist questions on foods and /or traditional medcines myths, perceptions and practices towards diabetes management).

A. Focus group discussion (FGD)

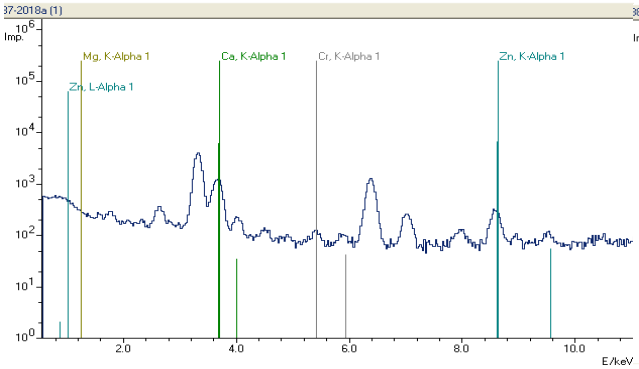
1. What are your perceptions towards diabetes?
2. Is this a common problem in this community and who are the most affected?
3. Are there any foods believed to cause and to treat the disease? Mention them and their preparation methods.
4. Are these foods consumed by other members in your community apart from diabetic patients?
5. What are the beliefs towards these foods?
6. Apart from these foods what else do people use for treatment of diabetes? And how do they prepare them
7. Are these foods and products believed to treat specifically diabetic patients?
8. In your opinion are these foods or products useful in treatment or management of diabetes?
9. Where do you get the information and advice on the food which you use to regulate blood glucose level?
10. Have you ever used conventional medicine on treating diabetes? If not why?
11. If yes, are you using both treatments? And how do you manage to use both treatments?
12. How do you compare the two treatments (traditional and conventional treatments)?
13. What do you recommend or suggest about those foods/products in the treatment of diabetes?

B. In-depth interview for traditional healers/traditional medicine sellers)

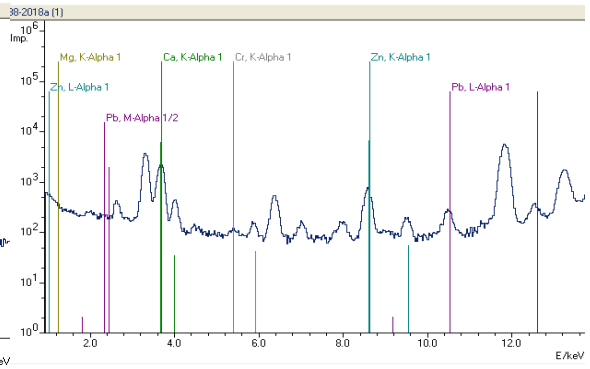
1. What do you understand about diabetes?
2. What are your perceptions towards diabetes?
3. Is diabetes can be cured or treated?
4. Are there any foods/products/treatment believed to cause/treat the disease? Mention them
5. How do you prepare those these things?
6. Is it possible to use those treatments without preparing the way do and be cured?
7. Are these foods/products used by other members in your community apart from diabetic patients?
8. How effective are these foods/products in the treatment of diabetic patients?

9. Where do you get the material for making these treatments/products?
10. What is the feedback from the community on the use of these foods/products?
11. How do you compare the two treatments (traditional and conventional treatments)?
12. What do you recommend/advice/suggest on those foods/products that you provide?

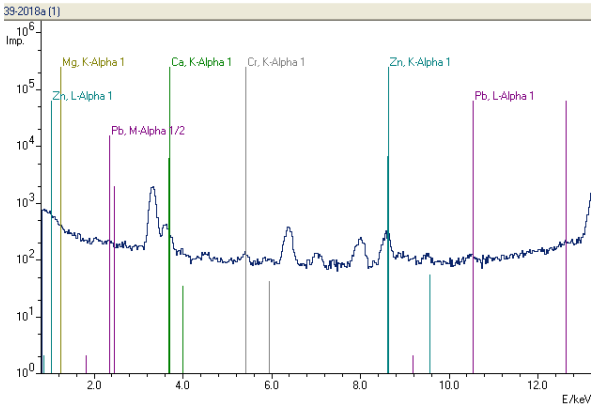
Appendix 2: Mineral analysis spectrum view



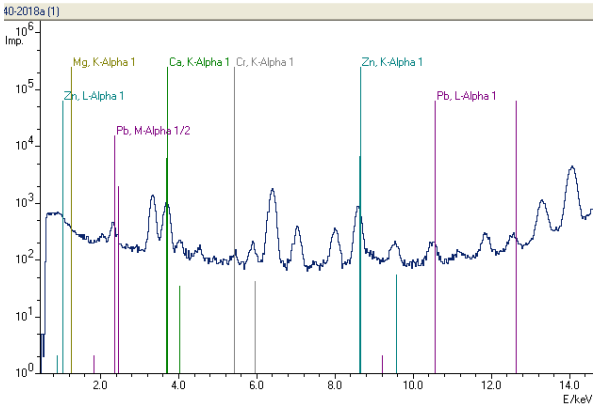
Lemon grass



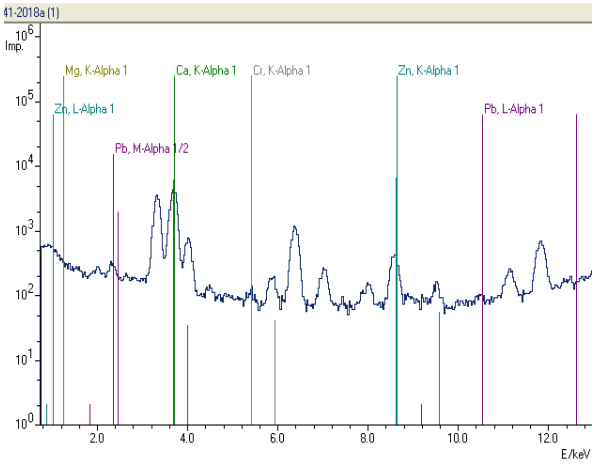
Okra pods



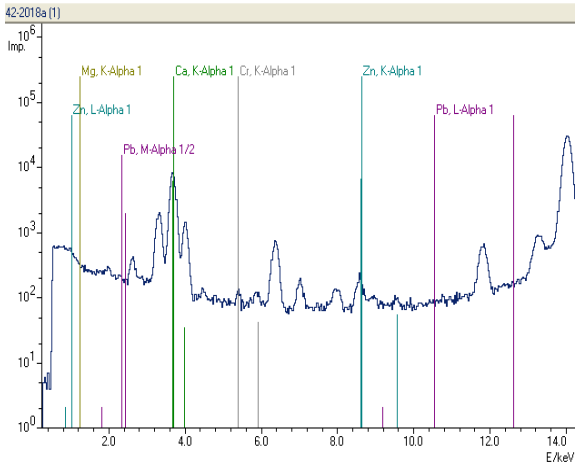
Avocado seeds



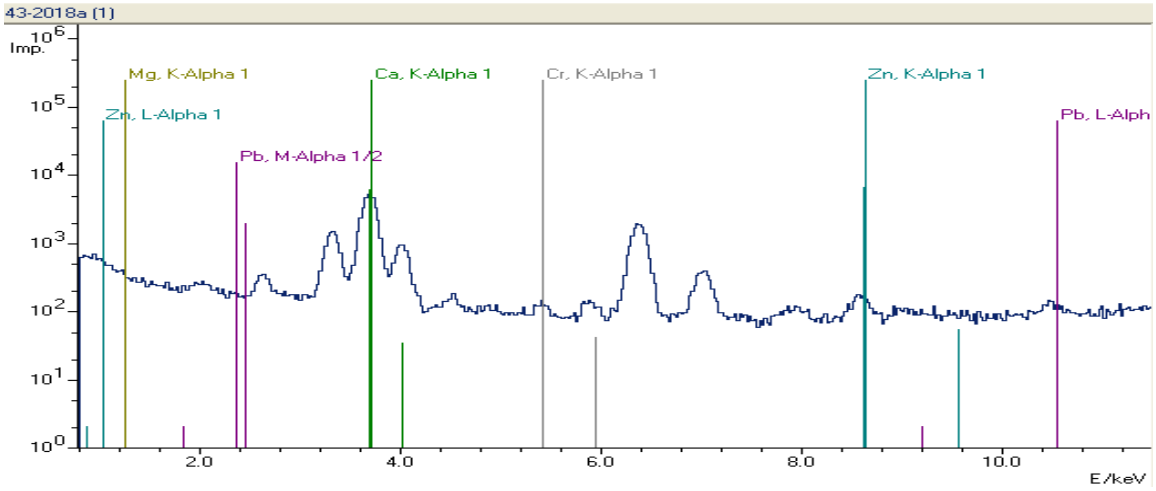
Moringa seeds



Moringa leaves



Soursop leaves



Black plum barks

Appendix 3: Common medicinal plant parts used as traditional medicines for diabetes treatment

Okra pods (*Abelmoschus esculentus*)

Moringa oleifera seeds

Moringa oliefera leaves

Soursop leaves (*Annona muricata linn*)

Black plum bark (*Syzygium Cumin*)

Lemongrass (*Cymbopogon citratus* stapf)

Avocado seed (*Persea americana* mills)

Appendix 4: Ethical approval certificate

THE UNITED REPUBLIC OF TANZANIA

National Institute for Medical Research
3 Barack Obama Drive
P.O. Box 9653
11101 Dar es Salaam
Tel: 255 22 2121400
Fax: 255 22 2121360
E-mail: ethics@nimr.or.tz

Ministry of Health, Community Development, Gender, Elderly & Children
University of Dodoma, Faculty of Arts and Social Sciences
Building No. 11
P.O. Box 743
40478 Dodoma

NIMR/HQ/R.8a/Vol. IX/2718

07th March 2018

Ms. Rose Kasole
C/o Dr. Haikaeli Martin
Nelson Mandela African Institute of Science and Technology
P.O. Box 447
Tengeru - Arusha

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: Investigation of food myths and their implications on management of diabetes in northern Tanzania (Kasole R. *et al.)* whose supervisor is Dr. Haikaeli Martin of Nelson Mandela African Institute of Technology has been granted ethical clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health, Community Development, Gender, Elderly & Children and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health, Community Development, Gender, Elderly & Children and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Site: Arusha and Kilimanjaro

Approval is valid for one year: 07th March 2018 to 06th March 2019.

Name: Prof. Yunus Daud Mgaya

Signature
CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Prof. Muhammad Bakari Kambi

Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, COMMUNITY DEVELOPMENT, GENDER, ELDERLY & CHILDREN

CC: RMOs of Arusha and Kilimanjaro
DMOs/DEDs of Selected districts

Appendix 5: Consent form

Informed Consent on Investigation of Food Myths and their Implications on Management of Diabetes in Northern, Tanzania

The following information will be read to the participants precisely.
You are being asked to be part in a research study on investigation of food myths and their implications for management of diabetes in Northern, Tanzania. I am asking you to be part of the study because you live in this area and you are a diabetic patient attending a clinic at this hospital. Please listen carefully and ask any questions you may have before agreeing to participate in the study.
What the study is about: The purpose of this study is to learn about your dietary practices, foods that you consume to manage your condition, perceptions and practices of foods used in the management of diabetes in this area.

What we will ask you to do: If you agree to be part of this study, I will have an interview with you, which will include questions about your dietary practices, foods you use on managing diabetes, perceptions and practices towards the used foods, and other questions related to diabetes, which will not take more than 60 minutes to complete.

Risks: There are no direct risks anticipated in this study, however, you will spend time to answer questions asked and sometimes you may find some of the questions being more sensitive to you.

Benefits: There are no immediate benefits to you for being part of the study, but you will be informed on the food myths to practice or not to practice, through your health care providers. Also, there will be an improvement in health care and management, since various health stakeholders may recognize foods that are potential for management of diabetes, so as to have alternative remedies.

Compensation: There is no compensation for being part of the study.

Confidentiality: Your answers will be confidential and the records will be kept private in such a way that only researchers can access. During reporting the study findings, I will not include any information that will identify you.

Participation is voluntary: Participation is completely voluntary, which allow you to skip any questions that you do not want to answer, decide whether to participate in the study or not and to withdraw participation at any time. This will not affect your services at this hospital.

If you have questions: The researcher conducting this study is Rose Kasole from Nelson Mandela African Institution of Science and Technology, email address: kasoler@nm-aist.ac.tz and phone no. +255762028294.

Statement of Consent: I have understood the provided information above, and have received answers to any questions I asked. I agree to participate in the study.

Name (Participant)…….. Date……. Signature……

Name (Researcher)……. Date…… Signature……